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Patterns and Castings as Witnesses.

BY JOHN M. RICHARDSON.

It is quite a common thing for apprentice patternmakers to be working in shops with which there is no foundry connected, and who therefore have to content themselves with seeing the castings after they are made, and the patterns after the molding is completed. To many such it may be exercising a new line of thought to consider what a chain of circumstantial evidence is presented by the castings and the patterns relative to what transpires in a foundry, and I will try, for the benefit of those so situated, to mention a few of the commonest facts that the castings and patterns testify to.

Sometimes a small pattern, when made whole, is of such shape that there is seemingly little choice as to which to consider the cope side; but by examining the casting we can tell at once which one the molder chose for that purpose, by noticeing the cope or parting line around the casting. This can always be traced in outline on castings made from patterns not parted, unless the entire pattern is in the nowel, and where patterns are parted it is seen around the corresponding place in the casting. On fine work it is scarcely noticeable, but sometimes on poor work this is shown in an unsightly manner, especially when the pattern is not in halves, by the part of the casting not in the cope being distinctly larger all around the cope line, owing to excessive rapping of the nowel. The cope being a straight lift and not rapped leaves this portion of the casting true to the pattern, but the nowel is unduly enlarged.

When we see a casting made from a pattern which was in halves come with one-half distinctly overlapping the other, we may know one of two things: either that the two parts of the pattern did not fit properly, owing to loose dowel pins, or else the trouble arose from a badly fitting flask. Patternmakers always attribute it to the latter cause.

A solid pattern which sees constant service in the foundry (a pulley for example), frequently shows great wear where the cope parting is made, having the varnish worn away, and a line cut into the wood all around the center line of the spokes in this case. The constant wear of the molder's trowel against the softer pattern is the explanation.

Sometimes it is a little mystifying to the apprentice to see an old pattern completely covered on the cope side with fine dents, which look as though someone had been trying to make a poor job of stippling. This is owing to a too vigorous application of the vent wire in the hands of the molder, who has allowed it to strike through the mold hard enough to bruise the pattern.

Again, he will be perplexed by seeing a hole on the top side of the cope half of a pattern, which looks as though a draw iron had been stuck into it, which is not so far out of the way, after all; but it was really done for a different purpose. This hole will commonly be noticed on patterns which leave the sand very easily (the top half of a valve or pipe pattern, for example), and is done by sticking a rod into the pattern, and securing it to the cope half of the mold, so that when the cope is lifted the half pattern will be sure to rise with it, and not start to loosen before the proper time and endanger the work. After the flask is turned, of course, the rod is removed, and the pattern lifted out in the regular way.

When core boxes are returned from the foundry having holes in various places through their sides, or ends, it shows where the core maker had to vent the core, these holes being bored to admit rods for the purpose. This is something the patternmaker need not trouble himself about, as he is not expected to do it, and, besides, only certain forms and shapes of core boxes require it.

A casting readily shows whether it was pickled, rattled, or made in facing and not pickled; for if pickled it shows rust all over, from the acid and water of which the pickle is composed; if rattled, it is worn smooth and the corners are more or less blunt where it constantly fell among other pieces as it revolved in the tumbling barrel. If cast in a properly faced mold the sand easily peels away from it, and when cleaned the iron is left in its natural color.

A patternmaker should always bear in mind that the cleanest and best iron will be in the nowel, as the dirt and impurities will rise, and oftentimes when a perfectly clean, machined surface is required that part of the pattern must be taken for the nowel, even if it will not mold as easily that way; or else the flask must be turner over, and the mold poured the other side up. Where such precautions are necessary it is common practice to mark "cope" on that part of a pattern which must be considered as such when the molder would naturally consider it the opposite. Then he can use either of the two methods he chooses that I have just mentioned to get a certain part of the casting in the bottom of the mold.

I think that foundries, as a general rule, are quite willing to accommodate in such particulars, in order to have finished surfaces come with clean iron, but the patternmaker must not imagine that a foundryman who has never seen a drawing of the machine, or part, can tell by intuition where any such foresight is required, unless the pattern is marked.

Another fact that a casting bears witness to is the gating. The place where the gate connects with the mold can be readily traced, and it is interesting to note the difference in size and position on various kinds of work and in different metals. Steel castings, for example, will show gate stubs several times larger in section than would be necessary for the same piece in cast iron. Thin castings, like a common stove spider, for example, will frequently show a place 2 or 3 inches long or more, and almost a mere line in width, on the middle of the outside surface, *i. e.*, the cope side of the casting. In these the iron is poured directly through a flat sprue into the mold, and the line which we see is the place where the sprue is broken off; whereas in most small machinery castings the iron is poured into a round sprue, from which a gate is cut to the edge of the mold, and no trace of the sprue itself is visible. It is common on a casting containing a large body of iron, to see a round spot an inch and upward in diameter chipped off smooth to match the surrounding surface on the cope side. This is more apt to be the trace of a riser than of a sprue.

Many castings having quite a body of iron will show bulging places on the sides, sometimes in patches and sometimes over a large surface. This may show that the mold was not rammed hard enough, but generally it tells the tale of

straining, owing to the weakness of the wooden flasks in which they were molded, especially if the flasks were old and not very strong.

If a casting is poured with cold and sluggish iron this will be plainly indicated by seams, called cold shuts, and these, with rounded and imperfectly filled corners, are the result.

Sometimes on a column or similar casting, having a large core, we see on the outside small, round bunches or buttons which were not on the pattern. These are done by the molder pressing the end of his trowel handle into the mold in the spot where he places a chaplet to make the core secure. What often appear to be nails showing in a casting, over or under a core, are but the remains of chaplets which did not melt perfectly in the body of iron that surrounded them. These do not appear, however, unless the casting is of such shape that further support and anchoring are required for the core than is given by the core prints.

Finally, to return to patterns, if we see a large and badly worn hole on one that is used constantly, in the place where it was lifted from the sand, it says "draw plate" plainer than any words, and I know that many a pattern suffers from this cause to such an extent that repairs far outbalance the cost of draw plates in the beginning.

If these rambling notes should help any young patternmakers situated as I mentioned at the outset to begin to observe and examine their patterns and castings, considering them as witnesses, I think they will gather enough evidence to convict on many points, circumstantial though it may be.

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Notes from the Manchester Shops—New Enterprises—Some Small Lathes—An English Milling Machine.

BY JAMES VOSE.

Sundry changes are in progress in the Manchester tool trade which may have important consequences. Until recently Manchester has been, generally speaking, somewhat neglected by the principal dealers in American tools, as regards direct representation. One reason for this has been that the Birmingham district during the inflated cycle building period absorbed a great part of the tool dealers' attention. A distinct portion of this trade was not due to genuine demand, but to company promoting tactics; and, as a consequence, now that the cycle trade is finding its level, some dealers find themselves acting as creditors to insolvent cycle companies. What may be called the "bread and cheese" tools now come in for their turn, and Manchester, being a comparatively virgin district, is now being attacked more directly. Messrs. Alfred Herbert, of Coventry, have opened a showroom here, and have now, after some months of effort, a fairly representative show of their products, those of the American Tool Works Company and J. A. Fay & Egan Company. For some little time as soon as a tool arrived at the showroom it had to be shipped to fill an order, instead of being unpacked and placed on view. Mr. Picken, who is in charge, was formerly connected with Messrs. G. Richards & Co., of Manchester, and is therefore well acquainted with the ground, and reports a steady trade being built up, their new hexagon turret lathes and full automatic screw machines (extra large size) being especially popular. Messrs. Cunliffe & Groom, Ltd., a Manchester firm of tool builders, have also opened a showroom in the city, where, in addition to their own lines, they are showing (and selling) American tools, among which I notice Prentice and Barnes drills; Gem, Seneca Falls and Barnes lathes, and various chucks, cutters and small goods. As much work as can be dealt with is in progress in their own shop and they are also using a number of American tools.

It is sometimes a doubtful advantage to some American tool builders to have English builders use a few in their own shops, as they can (and do) point out to customers their own strong points and contrast them with the weak ones of the American tools.

Messrs. Churchill, Ltd., Burton-Griffiths and Buck & Hickman all keep a representative on the ground practically all the time, and will probably fit up showrooms shortly.

One prominent American institution has recently attracted attention here, *i. e.*, the large grain elevator erected at Trafford Wharf on the Manchester Ship Canal. This elevator has been built, I believe, by a Chicago firm, and is understood to be designed on the latest and best principles for such structures. The ship canal itself has lately shown decided signs of eventually becoming a most valuable property. Though only just about beginning to pay the overdue interest on the loans advanced by the Manchester City Council (which is practically the owner of the canal), the indirect benefits to the district in the way of reduced cost of carriage and the increased prestige of the city are distinctly noticeable.

Orders for heavy tools for ordnance purposes, and for machining the various "elements" of water tube boilers, are very plentiful at present with Messrs. Hulse & Co., Ltd., and William Muir. The latter firm have recently completed some milling machines of phenomenally large proportions and range. In connection with an extract from a London newspaper, quoted in the "American Machinist" some little time ago, which stated that some "vertical lathes" had been ordered in America as they were unobtainable here," it is interesting to note that the last named firms, and also several other Manchester concerns, have built them for many years past, Bodmer, of Manchester being, I believe, a pioneer in that line. For some inexplicable reason they have not been "pushed" as they ought to have been, and thus Americans have now a good innings in that department.

Messrs. Kendall & Gent, another well-known Manchester firm, have just about got settled in entirely new works some little distance out of the city. The shop is capitally laid out, and, the driving and lighting being electrical throughout, some reliable data as to the merits of the electrical driving of tools in groups and individually, and the power required for various tools, will soon be at the firm's disposal.

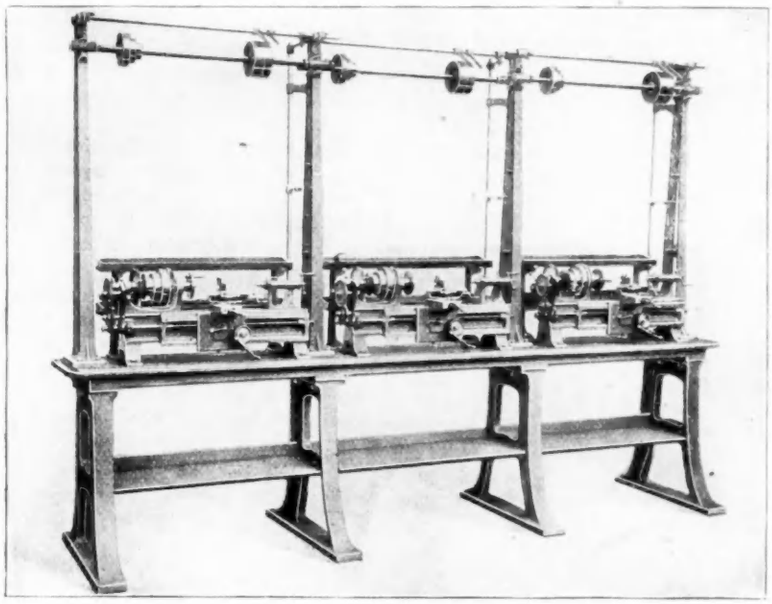
The storage of their valuable stock of patterns has received special consideration. Mr. Joseph Adamson, the well-known boilermaker of Hyde, is especially emphatic on this subject of pattern storage. A visit to Mr. Adamson and his shop is as good as a tonic at any time, and he is just the man to emphasize (more forcibly perhaps than mildly) your article on "Machinists and Tailors." His works are always open to visitors, and his ideas, methods and conversation are direct and to the point. He hopes "Chordal" will before long be cajoled or compelled to visit England and write a book on the same lines as the "letters," on British shop management. Messrs. J. Spencer & Sons of Hollinwood, Manchester, are, like the rest of Manchester toolmakers, quite full of work. At the time I was negotiating with them regarding an 8-inch swing, front slide, screw-cutting lathe (of which they make a capital example, the illustration showing a group of them as supplied to the Japanese Government), the castings were just appearing in the shops of a lathe for an Indian State Railway order, which has, as its test, to turn a 10-inch steel shaft down to 8 inch diameter at both ends simultaneously at one cut, with a traverse of ¼ inch per revolution. This lathe is intended for axle turning. Messrs. Spencer seem familiar with the far Eastern market, a large part of their work being repeat orders for it.

During the late strike and lockout the firm had to sell a number of their own tools out of the shop to fill customers' demands, and in consequence, a number of American lathes had to be installed on starting up. Though fully appreciating the systematic methods of manufacture of these recently designed tools, and the handiness of many of their features, they much prefer their own tools for durability and capacity for removing metal, which qualities they find of more

value to them than even handiness, and comparatively low prices.

As companion contrasts to the heavy and light lathes before mentioned, at this shop they make traveling cranes and small micrometers.

Messrs. Royce & Co., Ltd., electricans, have been installing some American tools lately, including a Landis grinder, a couple of "Little Giant" keyseaters, an

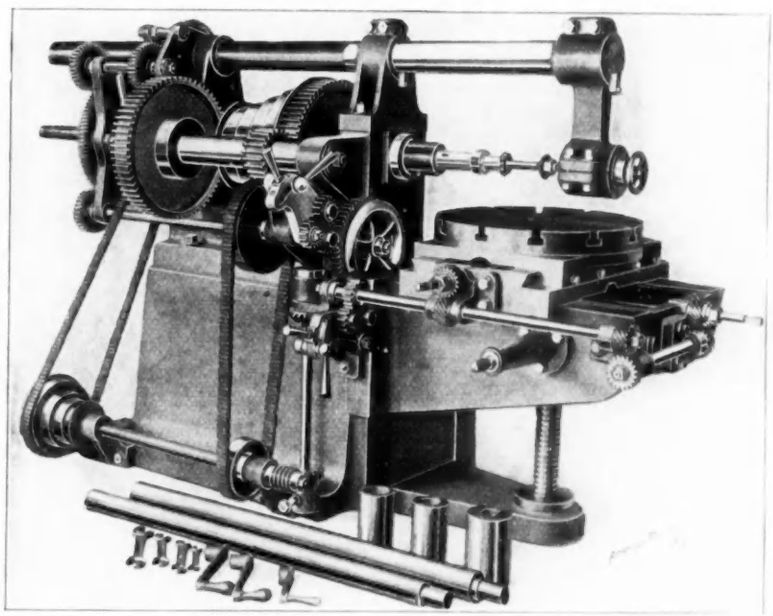


GROUP OF LATHES FOR THE JAPANESE GOVERNMENT.

American Tool Works Company's lathe, a Hendey-Norton toolroom lathe, Gisholt tool grinder, etc. In one group are to be seen the above American lathes, an Atlas (Manchester) Anglo-American lathe, a common 12-inch swing Yorkshire lathe, and a Richards Anglo-American lathe. At the time of my visit the Richards lathe was the favorite. Mr. Royce was also ordering a Jones & Lamson lathe, being especially impressed with the accuracy of the screwing dies, and a G. Richards & Co. boring and turning mill was also being installed.

Mr. S. N. Brayshaw, formerly head draftsman with Mr. Hans Renold, has recently started business on his own account in Manchester. His equipment for his line of work (milling cutters, etc.) is thoroughly up to date, and Mr. Brayshaw has every reason to be satisfied with the support he has so far received. He has in use, among other tools, a Reinecker relieving lathe, two Flather lathes, a Hendey-Norton toolroom lathe, two B. & S. milling machines, and a Prentice drill. In the grinding department I noticed a Landis grinder, Walker cutter grinder, and a Blounts tool grinder. Four American hack saws are kept at work sawing cutter blanks from the bar, and a Colburn keyseater was daily expected.

Coming to a rather heavier class of work Mr. T. Blears (who for some years has had charge of important productive departments a Messrs. Galloway & Co.'s engine and boiler works) has also made a venture on his own account. He is occupying the premises vacated by Messrs J. Holroyd & Co., on their removing to Milnrow, near Rochdale. He is introducing a combined milling, boring and facing machine, which seems extremely well adapted for the manufacture of boiler mountings and many articles required in marine work. (See accompanying half-tone and the description at the end of this letter.) Mr. Blears has had special experience in cost reducing on these classes of work, and the machine is the result of his investigations in that line. A well designed ice-breaking machine also forms one of his productions.



AN ENGLISH MILLING MACHINE.

As showing the well defined position American tools now hold on the English market (without anyone here appearing a penny the worse for it) it may be noted that Mr. J. H. Melloy, a gentleman well known in heavy machine tool making circles, is giving a special series of evening lectures at the Manchester Technical School on "English and American lathes." To quote from the school prospectus: "The course of instruction in this subject is intended to supply an account of the most recent methods and practice of modern machine shops. The subject for consideration during the present session is English and American lathes. Their construction will be taken in detail; special cases will be selected, and the best methods of production, and most suitable tools for the purpose (English and American) will be studied. The course will consist partly of lectures, which will be illustrated by lantern slides, and partly of demonstrations in the workshop." In conclusion I may say that it is hoped shortly to complete a new technical school in Manchester which will be worthy in every way of the city. The neighboring town of Salford has now had in operation for a year or two a technical institution which does it infinite credit.

Manchester, England.

[The combined milling, boring and facing machine made by Mr. F. Blears,

of Manchester, as mentioned, is shown in the half-tone so completely and clearly that little description is required. The machine is large and heavy, although the actual dimensions are not given. The main spindle is large in diameter and carries a sliding bar with feather and an automatic feed inward or outward. The upper bar also has a corresponding feed, and the two bars may be arranged to feed together or otherwise. Variable and reversible longitudinal and cross feeds are provided for the table. The circular table may be turned all round, and is self setting in four positions. A facing head, not shown, is provided which faces, flanges or other surfaces, feeding automatically either inward or outward, to 18 inches diameter. The spindle may of course be made to carry all the usual types of milling cutters. The use of the helical gears and the link belts is deserving of notice.—ED.]

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Engine Proportions.*

BY JAMES CHRISTIE.

If we choose some definite type of steam engine—say a locomotive or any class of engine—that similarly permits of uniformity in design, it is, of course, quite practicable to specify a standard of dimensions that will harmonize with the demands of service and conform to some canon of style for appearance. But for steam engines of widely varying design and dimensions, such as marine engines, pumping engines, or engines for miscellaneous power purposes, no such rigidity of dimensions is practicable, for reasons which will be given hereafter.

It is sometimes asserted that a steam engine is susceptible of as exact an analysis as a bridge, as though the designer might calculate a strain diagram for his machine and use that as a skeleton on which to elaborate his working drawing. We can not overestimate the necessity of an intimate and exact knowledge of the acting forces and their distribution throughout the parts of a machine—problems, by the way, which are sometimes extremely complex and frequently insoluble. And it is also essential to possess definite knowledge of the resistance of material to these complex forces; yet knowledge of this kind can be used only as a guide by the designer, and the mechanical engineer will always be influenced chiefly by precedent and experience rather than by calculation. In designing a bridge, the limitation of fiber stress is usually the guiding consideration; but in an engine this is rarely the case; the limitation of deflection is usually the vital consideration. The presence of sufficient material of the right kind in the right place, to prevent undue spring or deflection, is a *sine qua non* to make a good machine, from the structural point of view.

If any person will make a faithful attempt to analyze the forces that act on some particular member of a steam engine—say a shaft or a connecting rod—and, after making an algebraic summary of the combinations of tension, compression and transverse and torsional stresses resulting from forces that are constantly alternating and frequently acting at right angles to one another, and, running through the whole gamut of dynamics, attempt to calculate deflections, he will find it necessary to assume a more intimate acquaintance with the theory of strains and the nature of materials than any recorded knowledge will justify. But, assuming that these deflections can be calculated—for this is within the possibilities of human inquiry and investigation—we are at once confronted with the problem, What is the proper limitation of deflection? What amount of spring or yield can be tolerated in the member under investigation. This is a question clearly beyond the domain of analysis, and one to be answered solely from experience. Having determined a limitation to deflection to one particular case, we cannot rigidly apply the rule to all analogous cases. For instance, a transverse deflection or a torsional yield of a definite extent per unit of length, may safely be tolerated in a short shaft or other member of an engine; whereas the same yield per unit of length might be injurious in a longer similar member. Acceleration of forces or the inertia of moving masses of material must be considered as a determining factor in the problem, and the deflection may have to be limited in extent without regard to the length of member.

Discussing the subject from this point of view, I have chosen to confine my remarks to the shafts and bearings of engines, and will point out a few reasons why it is difficult to make these conform to any arbitrary standard. The dimensions are determined by two independent considerations: 1. Sufficient size to prevent excessive deflection or torsional yield. 2. To provide sufficient wearing surface to prevent excessive wear of journals. Usually, when the first condition is preserved, the other is provided for. An old rule which can be traced back to Tredgold limits the transverse deflection of shafts to 1-100 of an inch per foot of length. This rule must be accepted with reservation. In some cases deflection exceeding this limit is found in no way objectionable; in other cases, not more than half this extent of deflection should be permitted. When the bearings are flexible—and excessive deflection within the limit of ordinary safety affects nothing external to the bearings—considerable deflection can be tolerated. When bearings are rigid, or deflection may derange external mechansim—for example, an overhung crank—then the deflection must be more restricted. The effect of deflection is to concentrate pressure on the ends of journals, rendering apparent bearing surface inefficient. An example occurs in the modern direct driven electric generators, which involve unusually long main shafts to accommodate the armature and fly-wheel. Here a deflection of 1-100 of an inch per foot of length has proved excessive and has caused much trouble from hot bearings. I have latterly proportioned such shafts so that the deflection will not exceed one-half the aforesaid extent.

In some shafts, especially those having an oscillating movement, torsional elasticity is a prime consideration, and the limits can be known only by experience, and will vary under several conditions. Reuleaux says: "Limit the torsional yield to 1-10 of a degree per foot of length." This in some cases can be readily tolerated; in others has proved excessive. I have adopted the following as a very general guide:

Permissible Twist per Foot of Length.

.10 degree for easy service, without severe fluctuation of load.
.075 degree for fluctuating loads suddenly applied.
.050 degree for loads suddenly reversed.

These particular problems of the proper limitation of torsional and transverse deflection of shafts are cited as typical examples of the difficulties encountered in attempting to formulate any rigid system by means of which dimensions can be determined which would apply to any extended variety of designs of steam engines.

Wearing Surface.—When we attempt to formulate any universal system for determining the proper amount of wearing surface or limitation of pressures, we find the problem equally as difficult as when strength or stiffness only are considered. Sufficiency of wearing surface and the limitation of pressure per unit of surface is determined by several conditions:

1. Speed of movement.
2. Character of material.
3. Permissible wear of journals or bearings.
4. Constancy of pressure in one direction.
5. Alternation of the direction of pressure.

The last facilitates complete lubrication of surfaces and permits a greater pressure per unit of surface than the previous condition. Taking the product of pressure per square inch of projected area in pounds, and speed of movement in feet per minute, we obtain a quantity, which we can term the permissible foot pounds per minute for each square inch of projected area. This product will be found to vary in good practice under various conditions from 50,000 to 500,000 foot pounds per minute. For instance, good practice in later years has largely increased the area of cross-head slide sur-

* From a topical discussion before the Engineers Club of Philadelphia

faces for well-known reasons. For crossheads having maximum speed of 1,000 feet per minute, the pressure per inch of projected area should not exceed 50 pounds, giving 50,000 foot pounds per minute; whereas, crank pins of the requisite grade of steel, with good lining metal in the boxes and efficient lubrication, will endure 200,000 foot pounds per minute satisfactorily, and more than double this when speeds are very high and the pressure intermittent. On main shafts with pressures constant in one direction, it is advisable not to exceed 50,000 foot pounds per minute for heavily loaded shafts at low velocity. This may be increased to 100,000 for lighter loads and higher velocities. It can be inferred from the latter statement that the product of speed and pressure cannot be used in any comprehensive way, as a rational basis for proportioning wearing surfaces. The pressure per unit of surface must be reduced as the speed is increased, but not in a constant ratio. A good example of journals severely tested are the recent 110,000-pound freight cars, which bear a pressure of 400 pounds per square inch of projected area, and at a speed of 10 miles per hour make about 60,000 foot pounds per minute.

It would seem that only the broadest and most elastic rules can be adopted in designing machines when stiffness and wearing surfaces are the considerations, and any rule, however flexible, must be taken *cum grano salis*—to be modified and tempered by the judgment and experience of the designer.

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A Compound High Duty Air Compressor.

We are enabled to bring to the notice of our readers an air compressor which is interesting in itself and interesting also in the use of the compressed air furnished by it. The air is not used for the purpose of power transmission, as usually understood, although ultimately that is its function. The compressor here shown is in the service of the Indianapolis Water Company, and the compressed air is used in raising water from a series of wells and sending it forward for the use of the city. The wells in this case consist of vertical pipes, some of them 10 inches in diameter and others 8 inches, sunk in the ground to a depth of about 80 feet, each well being isolated, and the entire series distributed over a considerable area. The lower ends of these pipes are in a water-bearing stratum, and the water flows copiously into the lower ends of the pipes, but does not rise and flow at the surface as desired, and the air is employed in each pipe to help the water along. A central pipe 2 inches or 2½ inches in diameter conveys the air to the bottom, or nearly to the bottom, of the larger pipe. The lower end of this air pipe is open, and the sides of it near the bottom have numerous small holes. From these holes and from the bottom the air emerges and mingles with the water, rising with it and expanding with the reducing pressure as it rises, the practical effect being to reduce the weight of the column of mingled air and water to considerably less than that of the water alone, and the solid water below, under the pressure due to its depth, acts to drive the lighter column rapidly upward.

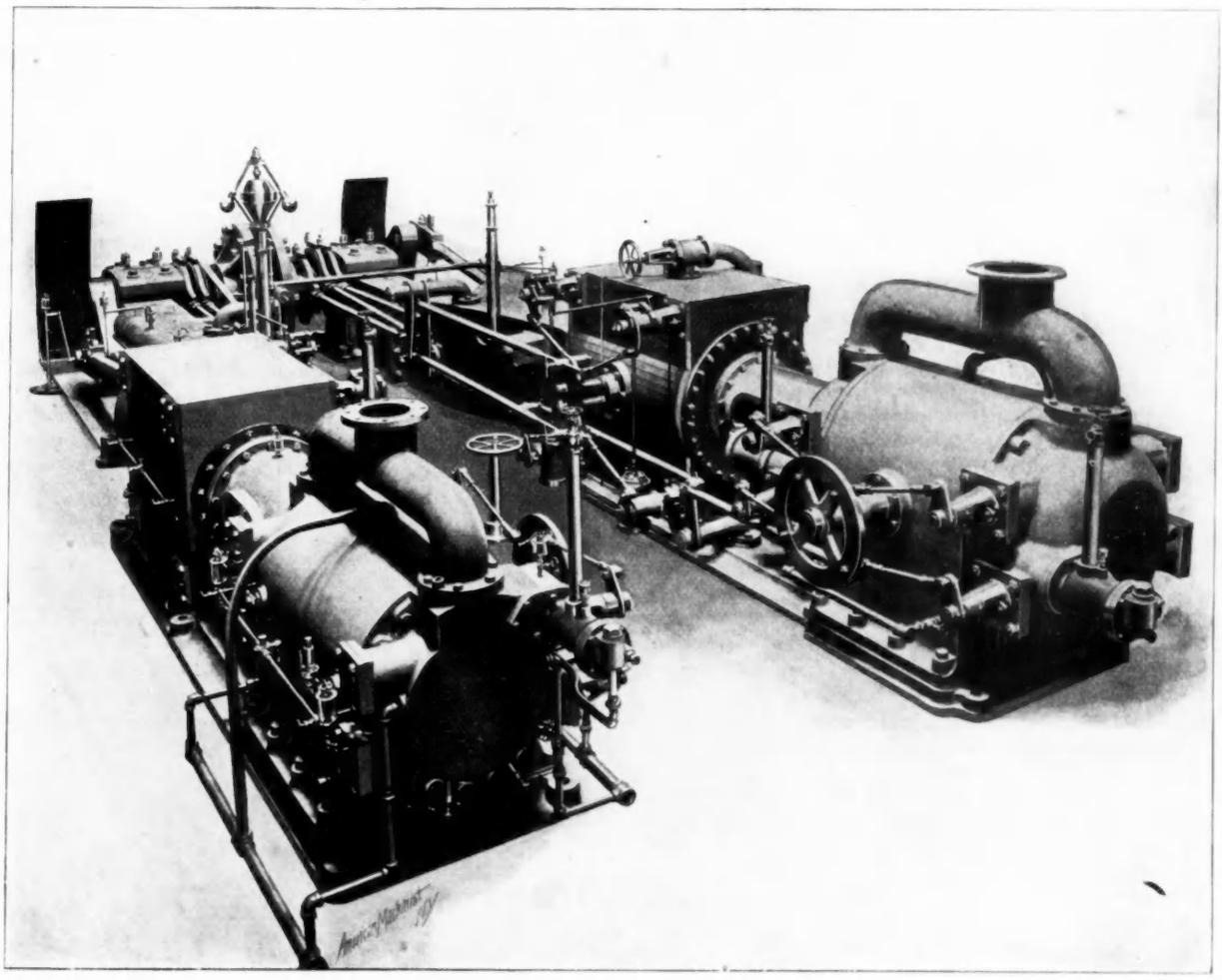


FIG. 1.—A CORLISS CROSS-COMPOUND AIR COMPRESSOR

It will be seen that the compressor for

this service need be in no respect a special machine. Its work is simply to compress and deliver air at the pressure required. The compressor, therefore, is merely the latest improved standard machine of its builders, the Philadelphia Engineering Works. An identical machine was recently shipped to South Africa.

The large half-tone, Fig. 1, gives a very complete view of the compressor. The photo was taken without the fly-wheel, but otherwise shows the entire machine. It is a cross-compound Corliss engine with cross-compound air compressing cylinders, one air cylinder being attached tandem to each steam cylinder, the larger or low pressure cylinders, both steam and air, being at the right, and the smaller or high pressure cylinders being at the left of the view. The steam cylinders are, respectively, 40 and 22 inches diameter and the air cylinders 38 and 23 inches, with a common stroke of 48 inches. The normal speed of the compressor is from 60 to 100 revolutions per minute. The high pressure steam cylinder has a single wrist plate action and the low pressure cylinder has a double wrist plate. The cut-off for both cylinders is actuated by the governor in connection with an improved Corliss liberating gear. If the air pressure exceeds a determined maximum pressure an air cylinder attachment to the governor relieves the weight and the governor then requires a slower movement for the constant cut-off required. The governor, on the other hand, in case of a fall of pressure beyond the capacity of the compressor to compensate, will not allow the engines to run too fast.

The air cylinders have positively moved inlet valves operated by eccentrics upon the main shaft connecting through rocker arms to the wrist plates. Fig. 2 shows the wrist plate, rods and rocking valve levers of the high pressure cylinder. While the delivery valve lever has also a positive connection to the wrist plate, the valve is not positively connected to the valve rod. The relation of the valve rod to the valve and the range of independent movement is shown at *A*, Fig. 3. The delivery valves are positively closed by the valve rod, but are opened, and at the right moment, by the operation of the differential piston connected with a valve lever within the chest, as shown in Fig. 3. This differential piston, although rapid in movement, does not cause any knocking of the parts, as the by-pass pipe provides a cushion. Large port areas are secured with small clearance. Thus in the low pressure cylinder the area of the inlet port is 84 square inches, and of the delivery port 72 square inches, or 1-16 of the piston area, while the total clearance of this cylinder (whose stroke is only 1.26 its diameter) is 1.5 per cent. The cylinders are completely water jacketed and an efficient intercooler is provided. As a memorandum of what modern air compressors may be expected to do, it is worth while to note the guarantee offered by the makers of this compressor, which is that it shall show 88 per cent. of the theoretical isothermal efficiency, and that the friction of the machine at rated duty will not exceed 10 per cent. of the indicated horse-power of the steam end. Thus

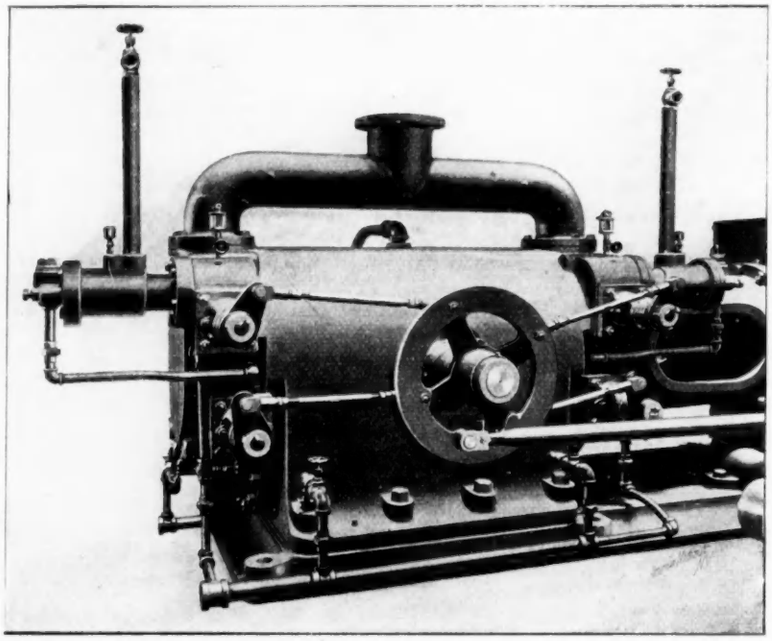


FIG. 2.—VALVE MOTION OF HIGH PRESSURE AIR CYLINDER.

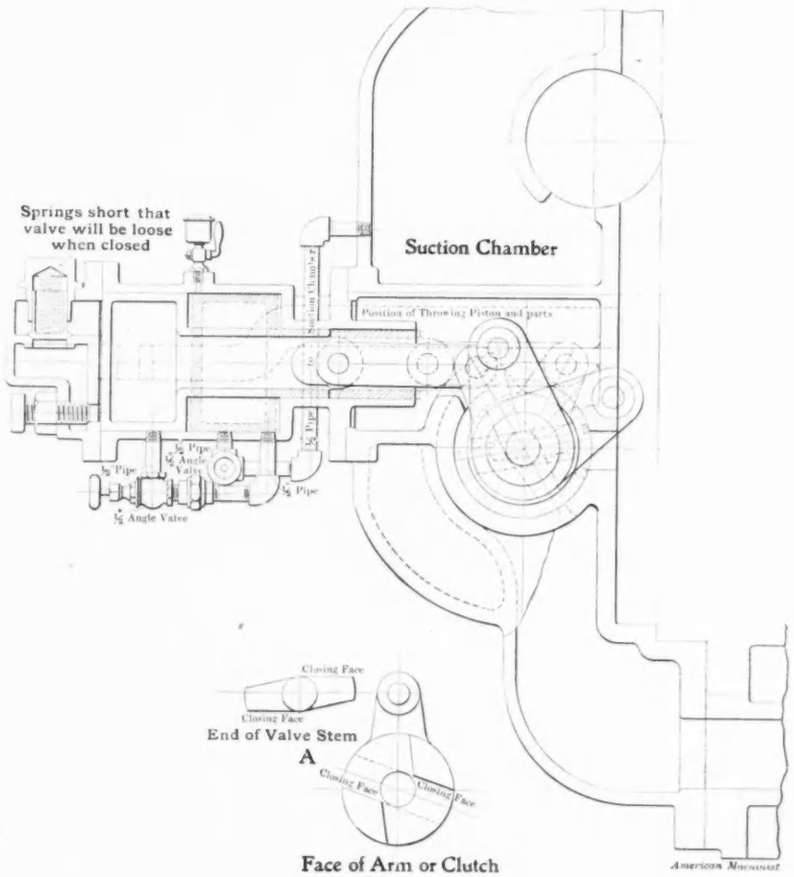


FIG. 3.—DELIVERY VALVE ACTION.

the power represented by the compressed air, after it is cooled to initial temperature, will be 90 per cent. of 88 per cent., or 79.2 per cent. of the indicated steam horse-power.

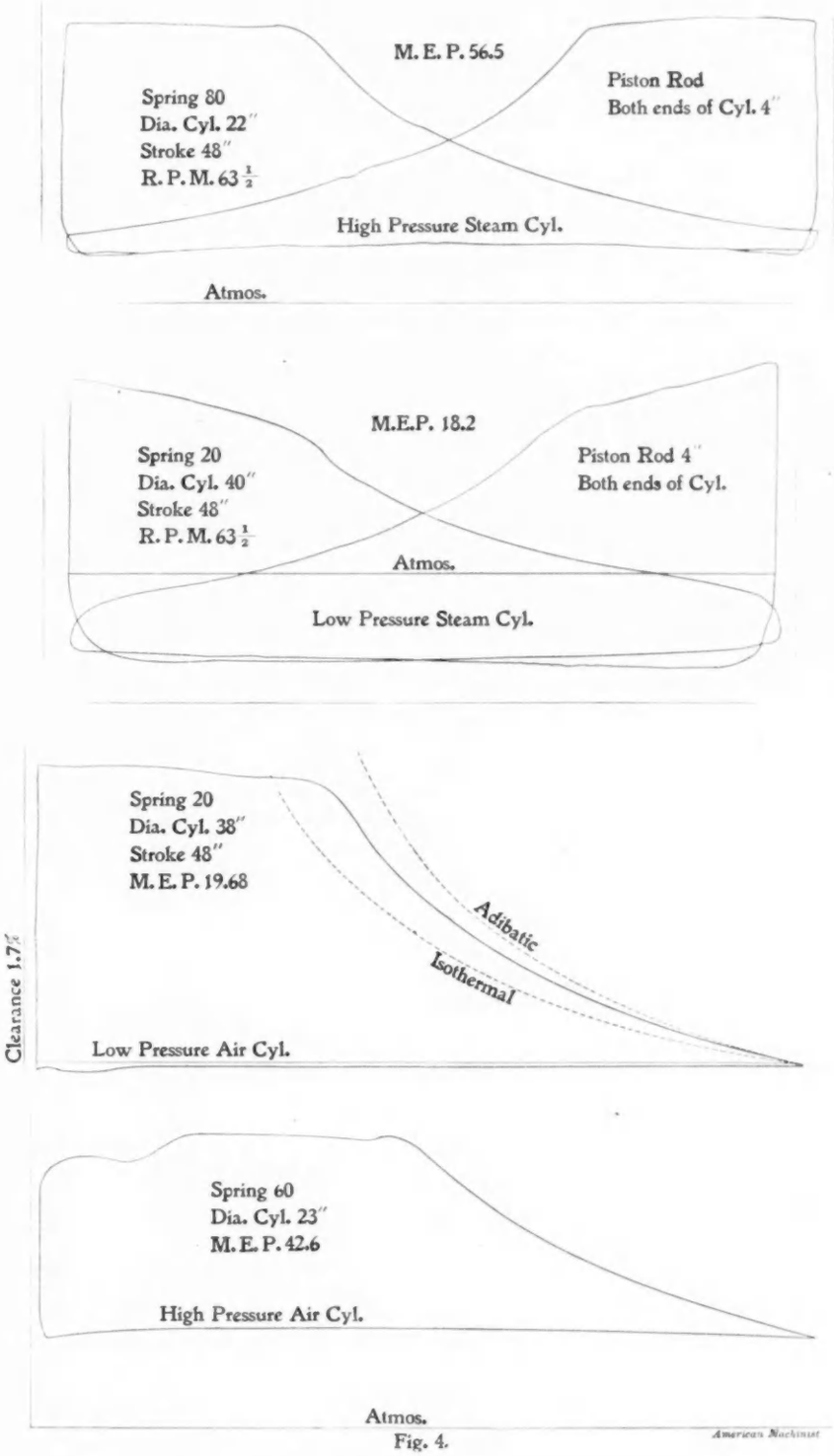


Fig. 4.

SET OF INDICATOR DIAGRAMS FROM STEAM AND AIR CYLINDERS.

In Fig. 4 is given a complete set of indicator diagrams, with all the necessary data pertaining to them. The delivery line of the high pressure cylinder may invite some remarks, and its peculiarity is attributed to the delivery pipe from the compressor, which contained seven elbows, with short sections of pipe between them, and the receiver was at a considerable distance, instead of being placed as close and with as direct connection as possible. The intake or low pressure air cylinder shows a very complete filling of the cylinder at the beginning of the stroke and also the delivery of a large proportion of it, 95 per cent. of the full capacity of the cylinder being shown to be so delivered.

▲ ▲ ▲

Air versus Whiskey in Fire Room.

Some naval surgeons are now calling attention to a state of affairs in the fire rooms of naval vessels which certainly calls loudly for a remedy. Surgeon John W. Baker, of the Bennington, has submitted a report, in which he says:

"At present the engine room and machine shop are cut off from all fresh air. There are two large ventilators rendered perfectly useless by the pilot-house being built directly in front of them, and so far obstructing their use as to actually limit by interference the movement of the cowls.

"Dripping with perspiration, covered with coal dust, pores of the skin clogged with dirt, thus impeding the cooling effects of evaporation and largely reducing such surfaces, the men stand, inhaling the fumes of recently hauled or cleaned fires, and fighting against the depressing effects of heat until their hearts refuse longer to impel the blood, and they are either artificially revived by stimulants, which are furnished each watch, or else are carried below to see the doctor. This is the history of each run at sea, and the entries under vertigo, prostration thermica, febris thermica, syncope, and verium defectio tell the story to all who may calmly and without prejudice study the history of such cases.

"A battle, the loss of a ship and many lives may at any time hinge on the quick turning and effective handling of a ship, and no one will deny that plenty of steam is essential to all. This abundance of steam and its maintenance require not only that fresh air shall be supplied to the fuel, which is provided for by blowers, but that good air, fresh air, cool air shall reach the lungs and envelop the skins of the men who are engaged far below, away from all the attendant and nerving excitement of the battle, in the struggle to keep their own temperature down and that of the fires up. The only way to meet this problem is to follow the methods pursued in arriving at results in general, namely, study and attention to detail.

"We should build our ventilators larger and higher, and make them more numerous; provide our fire rooms, bunkers and engines rooms with fans on a large scale, until we no longer are content that men should, in these days of modern science, toil and labor in a vitiated atmosphere at temperatures varying from 130 to 170 until they are temporarily exhausted or permanently disabled, and that, too, long before the period assigned to men who live on deck in fresh air and wholesome sunshine, and who are never called upon

to make the physical exertion, save in unusual emergencies, that these men must make every day, if we would maintain our speed at sea, speed and turning in evolutions; in fact, the efficacy that is not only desirable, but absolutely essential for our success in warfare, and for which our ships are constructed."

▲ ▲ ▲

Pattern Making—An Example for Open Frame Core Boxes.

BY JOHN M. RICHARDSON.

In the accompanying drawing Fig. 1 represents a certain fixture to be used on a large power press for performing a special operation, and it is shown without dimension lines, finish marks, or location of drilled holes, as these would have no bearing upon the construction of the pattern. The core prints are shown in dotted lines. The pattern presents no special difficulties after the various lines have been picked out, and it is an excellent example of what I mentioned in a recent number, namely, the making of open core boxes to be rammed up on the plate, and drawn away without turning over or disturbing the cores. In this case there are three separate core boxes, all of the open frame type.

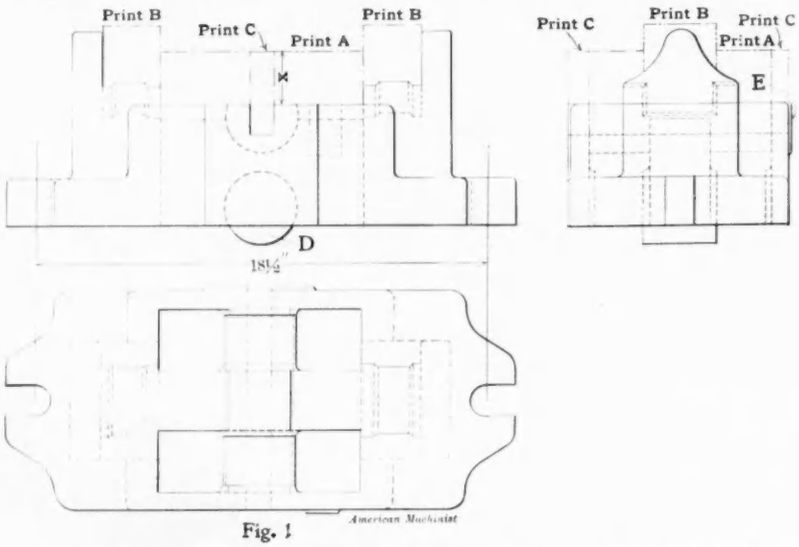


Fig. 1

CASTING WITH CORES MADE IN OPEN FRAME CORE BOXES—CORES IN DOTTED LINES.

On referring to Fig. 1, it will be seen that there is a large rectangular hole entirely through the center of the casting, having two bars crossing it at right angles; one, running longitudinally, having a rectangular section, with a boss on either side, and the other, a little more than semicircular in section, joining this first bar, and having a rectangular slot through it which extends entirely through the width of the casting. This gives a simple example of one core passing through another. This pattern has no core print, as the core is of such shape that one does not seem necessary. The part *D* is doweled on loosely, so that the pattern may be placed flat on the mold board, and the loose piece *E* is held in position by wires, and removed after the pattern has been withdrawn.

Fig. 2 shows the three core boxes. Core box *A* is an open frame with one screw at each joint to hold it securely while ramming the core, and is then unscrewed by the core maker. Hooks would be quicker and just as good. Places are cut through two sides for the bar *G* to slide through easily, and the part with parallel sides on loose piece *G* marked *x* is equal to *x* on core print *C* Fig. 1, and at least 1-16 inch wider, for this part is simply a print, forming a slot in the core *A* to envelope the core *C*, and when one dry sand core passes through another, an allowance must be made for an easy fit, or great trouble is caused.

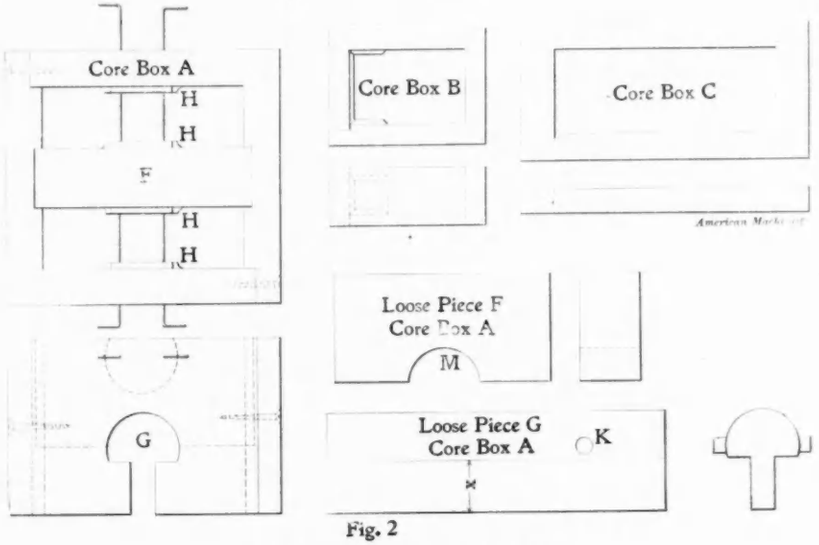


Fig. 2

OPEN FRAME CORE BOXES.

On the other two sides of the box, places are cut for the bar *F* to drop into, and on each side of this bar, and directly opposite on the sides of the box the loose spots *H* are held by wires. It is necessary in this case to have two wires go through each spot as they are not quite round. The full circle of the spots on the bar is, however, completed in the casting by the piece *D*, Fig. 1. The two bars *F* and *G* are shown separately in Fig. 2. *G* is made long enough to grasp by the hand while being drawn out, and a pin, *K*, is put in for a stop. A place, M, is cut on the bar *F*, to fit over bar *G* when in position.

To release the box from the core, draw out the bar *G*, remove the wires, and lift up the bar *F*; then the sides can be drawn away, and the loose pieces picked out.

Core box *B* is a simple frame with the finishing strips on three of the sides. There are two of these cores to set, each one adjoining the large core *A*

Core box *C* is for the slot core, which is to be placed first in the mold, and enveloped by the large core *A*.

▲ ▲ ▲

The Way We Weigh.

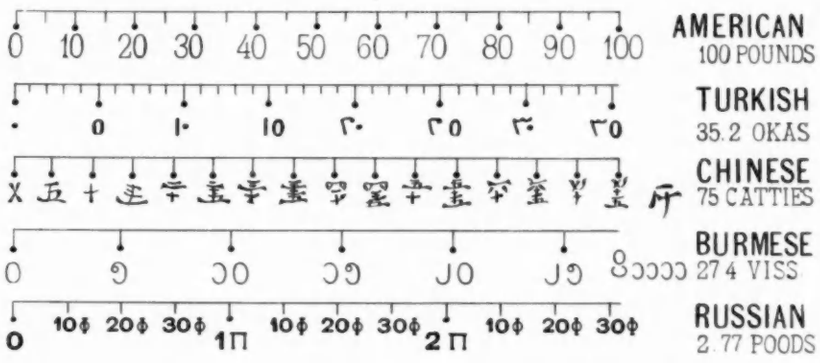
BY W. H. SARGENT.

When the X-rays were first announced we marveled at their power of penetrating substances not commonly permeable by the usual forces of nature, as light, heat or electricity. We forgot the other great and universal power of nature, the force of gravity. We thought it remarkable that this new force, half light and half electricity, could pass at all through certain substances, even though a second layer greatly retarded and a third thickness might resist it altogether. We forgot that the "rays" of gravity pass through all substances alike, without regard to their densities or to the number

or thickness of the different layers. A stone is attracted to the earth neither more nor less by being placed on top of another stone; pass your hand under the pendulum of a clock and it will not vary its tick by a single beat. This attraction, which we call weight, is alike, or practically so, at the tropics or at the poles, indoors or out, up a mountain or down a mine; it never runs down, the pressure never gets low, the current is never off.

Apparently this force was fitted by nature to be of service to man in his commercial relation to different people and other nations; but while the force is universal, man's application of it is not, for different nations have different standards of weight. Judging from the present confusion, it would seem as if the scale business had been at its hight at the time of the tower of Babel. Every nation is a law unto itself. The Russian has his *fund* and the German his *pfund*. The Spaniard has the advantage of us in one respect—his another kind of ounces, while a fluid ounce is not a standard of weight, but of bulk. Our abbreviations well correspond to our system; if lbs. signifies pounds, then the workman lbs. his fingers, and we send vagrant dogs to the dog lb and pay our English friends in lbs. sterling. Since a dollar bill weighs just about 24 grains, *dwt.* had better stand for dollar weight than for pennyweight, and the obsolete Roman-English denarius weight, which the abbreviation stands for, has no modern meaning. England, Russia and America are the only civilized countries in which the metric system does not now prevail. It is legal enough in this country, but who uses it? Did you ever buy a kilo. of tea or a litre of milk? We sing psalms in long meter, but we fail to use and other metre as a standard of length.

Mexico has just adopted the metric system of weights, but shorn of many of the fussy exactions with which it was sur-



VALUES OF FOREIGN WEIGHTS COMPARED WITH 100 AMERICAN POUNDS.

libra weighs rather more than our pound. The "unspeakable Turk" weighs in *okas*, and the Chinaman writes *catties* in tea-chest characters. Not only between different nations does this confusion exist, but between different sections of the same country, the *maund* of India varying from 24 to 82 pounds. For use on the frontiers of adjoining countries weighing machines are graduated to weigh in two or more standards, as metric and American, or English and Japanese, and the linguistic talent of a scale has even been extended to comprise half a dozen different standards. "She speaks a various language," to quote from "Thanatopsis." The Englishman counts in *stones* and *quarters*, and uses an even beam, thereby handling as many pounds of weights as there are pounds in the load. We laugh at his conservatism in preferring so many weights, because our system is so handy, dontcher know. We sell coal on the car by the long ton, on the cart by the short ton; a hundredweight is not a hundred of any kind of weight; a "cental" is the same Anglicism in a Latin dress. Buy a pound of soda at the grocer's and you will get 16 ounces; at the druggist's you get 12 of rounded by its French originators. Cast iron scale levers are permissible; a decimal ratio of multiplication for each lever is not demanded, and a new beam may be inserted in an old scale, provided it will then conform to the metric standards of the State or municipal sealers. Many people object to the metric system, not because of any difficulty in using it, but because of their inability to guess by it or to think or talk in it. Their acquaintance with the present system is such that they are able to make a very close estimate on the weight of any article with which they are familiar, but are confused at any mention of anything metric. "A pint's a pound the whole world 'round" is system enough for them. Manufacturers have a real objection to a change, because of the expense entailed in altering jigs, templets and gages, as well as shop drawings, to accommodate what they consider a mere sentiment. It is probable that the system of metric weights would cause less trouble in this respect than that of measures, since the burden of the change would fall upon scale makers who are prepared for it, and who would welcome anything which would relieve the existing confusion. International progress will soon demand a uniform schedule of weights, which will almost certainly be some decimal system, and, if so, it will naturally be the metric; not because it starts from any definite standard, but because it is an orderly, coherent, decimal system throughout.

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Observations of an American Engineer in China and Japan.

BY AUGUST C. CHRISTENSEN.

There will soon be for the first time in the history of China a modern waterworks, of American design, installed in one of their walled cities. In the early part of this year the writer was called upon to proceed to Shanghai, China, in order to examine into and make an estimate for supplying the inland city with a system of water works, pumping engines, standpipe, watermains, hydrants filter bed, etc. The foreign settlements, the English, French and American, have an excellent waterworks, which has been in operation for many years; their pumping station is about three miles down the Wang-poo River; the station has three 2,000,000 gallon horizontal engines, one direct-acting single engine, and two cross compound fly-wheel engines with attached air pumps. Steam is supplied by four Lancashire boilers, 6 feet diameter and 26 feet long (one of which only was in use running two engines); two settling basins about 200 feet square, six filter beds about 100 feet square, and a clear water basin. The river water is very muddy, but the water delivered is quite clear. This waterworks is English—built and managed entirely by Englishmen. Owing to the high price charged for this water, the French concession is now building its own waterworks; that is, the settling basins and filter beds are in course of construction; the contract for the engines standpipe and watermains had not been let last July, when I left that city. It was understood that there would be some delay in this.

The Inland Water Company will have its pumping station, filter beds, etc., about four miles up the Wang-poo River, quite near the Arsenal, and the watermains will be laid for most of the distance along the river front street, "The Bund." The water tower will be located on the same street, and on the corner of the narrow street that leads into the city there will be two horizontal cross compound fly-wheel engines, each of a capacity of 2,000,000 gallons in 24 hours pumping against a head of 100 feet. The old city has never been surveyed for publication, but a map has been furnished the writer for the purpose of estimating. The contour is a kind of a polygon, but curved on one end, about 5,000 feet wide and 7,000 feet long. The wall is of stone,

30 feet high and about 12 feet thick. There are four gates, north, south, east and west. The streets are very narrow and crooked, the widest 12 feet from house to house, but the walking width is only 7 feet, there being two stone steps, 30 inches wide, on each side, which are encumbered with counters or benches for the display of wares. There is a trench or sewer in the centre, two feet square, with brick sides and a mud bottom. The paving is composed of stones 5 feet long, 12 inches wide, 5 inches thick, which cover the sewer. These stones lie loosely, and the odor in that city is very strong. There are many streets as narrow as 6 feet and 8 feet, with no trench but just an open gutter on each side. These are paved with small flat pieces of stone set on edge; the water flows into creeks about 20 feet wide; these are rather open sewers. The bridges over the creeks are 3 feet higher than the streets, with wide stone steps on each end. All merchandise is carried suspended on bamboo sticks by one or more coolies, who make a loud breath with each step, louder according to the weight they carry. Wheelbarrows are used to some extent, of poor design, the wheel being in the centre and the load either on one or both sides. Passengers are also carried on these vehicles. No carriages or wagons can be used inside the wall on account of the narrow streets, not even the small two-wheeled cabs called rickshaws, drawn by a coolie, though hundreds of these are used all over outside the walled city.

The writer spent several days going through these streets. At the entrance, but still outside, there was an introduction by one of the Chinese members of the water company to a high official, and, after partaking of the inevitable tea, the force was collected, consisting of the official, an interpreter, three policemen and three men with pickaxes and crowbars. On account of the dense crowd of people we had to walk single file (the official was carried in a box), all the vendors and carriers shouting to each other to make way.

Shanghai is situated on the Wang-poo River, a tributary of the Yangtsze Kiang, 15 miles from the confluence of these rivers, which is about 15 miles from the Yellow Sea. The Wang-poo River is at times too shallow for large ships to come up to the city, but all coasting steamers run up. The ships which ply between Hong Kong and America stop at the mouth of the river, which is called Woosung. The fort at that place has been commanded by German officers, who were discharged last May and the soldiers moved. The land is now for sale, and there is no doubt that it will be bought by merchants and manufacturers, and docks and warehouses ("Godowns") built, as it is on deep water, and the old condemned railroad has been rebuilt and was to be opened for traffic this autumn from Woosung to the city. Some years ago it was stated that the Chinese Government had seized this road and run the cars and locomotives into the sea, but this is not true; they bought it, took it all apart and stored it away.

The harbor at the city has a fine appearance. There is an old but very trim United States warship with paddle wheels. Sea-going ships come and go every day, also good-sized river boats, which go up the Yangtsze Kiang, stopping at all places, Nanking, Hankaw, etc. A little below the city are wharves, and the harbor presents a busy appearance.

There are several cotton and silk spinning mills running night and day, dry docks and engine works. About three miles up the street, "Nanking road," is a fine one-mile race course, cricket grounds, etc.; then right in the city, on the river front, is the public garden, not as large, but as fine as that in the city of Boston. There is music in summer every afternoon from 5 to 6:30 by a brass band of thirty men, and to one or the other of these places everyone goes after office hours.

The shipbuilding, boiler and engine works are well located on the river, their offices and storerooms being right on the streets connecting with the shops and yards down to the water front. They build river steamers, tugboats and launches of metal and wood. Everything is done in the works except the smaller work, which comes from England. These works are equipped with machine tools of the old design, for slow speeds and fine feeds, and the sooner they go to the cupola the better it will be for the shops. Labor is very cheap; mechanics receive up to 50 cents per day, and laborers from 10 to 15 cents. To equip that country with modern tools would take many years' work of all the tool works in America. Wood-working machines are also needed there badly. Agents to sell machine tools there should be strictly first-class mechanics, to set up and run them. A mere rattling salesman will not do nearly as well. This applies also to engines and all kinds of machinery. The workmen are all natives, wearing blue overalls, their long hair braids being coiled under their hats. The foremen are Europeans, who have to look sharp in order to get the work out correctly, and most all laying out and measuring they do themselves. All assistant draftsmen are natives. In the small shops they have scarcely anything to work with. I noticed a man filing the teeth of a wheel which he held between his naked legs, sitting on the floor; another was sawing lath, about six in a bunch; his bare feet held them down, his saw was an old-fashioned bow with a twisted rope to tighten the blade, and he did this work for months.

It is surprising that American manufacturers are not better represented in that country. I have met several Chinamen of influence and wealth in connection with the waterworks who do not know much about American machinery, but they promised to pay us a visit as soon as they get time. The better class of Chinamen in China are a different people from what we generally see here. They are handsome and dignified people and excellent business men. What they want is a practical illustration of what America can accomplish.

I have been told of an instance wherein a Chinese capitalist was to witness the working of a new machine with a view of purchasing it. It happened that by some mistake of the workmen the machine did not work, when the Chinaman suddenly left in disgust and never wanted to look at it again.

The correct number of inhabitants of Shanghai does not seem to be known. There are said to be 800,000, of whom about 200,000 are within the wall, crowded in an area of 1¼ square mile, and about 6,000 foreigners; the largest number of foreigners in any city in China. The city of Pekin in 1893 is said to have had four million inhabitants in an area of 48 square miles, inclosed by a wall 63 feet high, 48 feet thick at the bottom and 36 feet at the top. There are twelve towers, 96 feet high. The map shows a well arranged city, it being a parallelogram, with all the streets at right angles. The Emperor's palace is right in the center, surrounded by another wall. The main avenues are 100 feet wide. Some of the smaller streets have a gate or passageway leading into them, but the streets are muddy or dusty.

Shanghai being an open city with a complete foreign government, it will probably not be affected by the retrograde movement that is at present threatening China.

In Japan the machine works are about in the same condition as in China. They should and must have modern tools in order to build their own engines, etc., for as low a price as America can furnish them. The waterworks are chiefly of the gravity system; only a few were visited. In Nagasaki, six miles in the country, is a small collecting basin; it is about an acre in area, on the side of a hill, with an overflow. Below this basin, about 30 feet down a stone stairway, are several filter beds, one of which was in process of being cleaned. This was done by small women carrying the sand away in baskets. The ships get their coal in Japan, either in Nagasaki or in Moji. The loading is also done mostly by women, about 100 in each coal barge. The coal is shoveled in small soft baskets, which are passed from hand to hand up into the side of the ship with great rapidity, but our elevators would do it in one quarter the time.

There is an excellent waterworks in the city of Osaka, about 20 miles from

Kobe, with large reservoirs. The engine and boiler houses are of large proportions, and they have five large modern pumping engines standing in a row, four of which were in operation. They are of the duplex, horizontal, direct-acting, triple-expansion type, three cylinders on each side, with attached air pumps on the end. They were built by the H. R. Worthington Company at their works in England. In an adjoining engine room are several fly-wheel engines—I forget the makers—one of which was in process of alteration, receiving a larger water end. In Yokohama and Kobe are several American machine tool stores with a few samples of small machine tools.

The Shanghai Club is a fine establishment, also the German club, "Concordia," where one meets with the best society and a cordial greeting. The principal hotels are the Central Hotel, English; the Astor House, American; and the Hotel des Colonies, French.

As stated above the water supply in the foreign settlement in Shanghai is good, but it is surprising that there are no modern improvements in the houses, only bath tubs. Of course they do not want to pollute the river, but the sewage could be pumped away about 20 miles to deep water, as is done in several places in the United States. What is also wanted are elevators in the office buildings and hotels. These buildings are only three stories, but very high, and it is hard work to go up many steps in that climate in summer. These improvements have been suggested and perhaps something may be done in the future.

There is an artificial ice plant, but probably of small capacity, as ice is too expensive. Some American firm should start a 300-ton plant and sell ice at a lower price if possible; but Japanese coal is about $6 per ton.

141 Broadway, New York.

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The Moment of Inertia of Built-up Beams.

BY E. A. DIXON.

Some time ago the "American Machinist" contained an article on a method of finding the approximate moment of inertia of plain beams,* and the impression was conveyed that a knowledge of calculus was necessary for more accurate results. There are, however, other and more exact methods, which are available to anyone who understands simple arithmetic. Almost every engineer's pocket book, particularly those published by the various steel mills, contain a number of formulæ for the various shapes met in practice. But when these shapes are built into a beam, the pocket books only give one method of finding I for the resulting section. This method involves the calculation of I for each element of the section, about its own neutral axis, and the transference of it to the previously found neutral axis of the built-up section. In this method the neutral axes for the elements are those parallel to the axis of the section.

There is another way of finding I which has some advantages over the preceding method. It is not new, but is not found in the pocket books. The formula is simple and easily remembered.

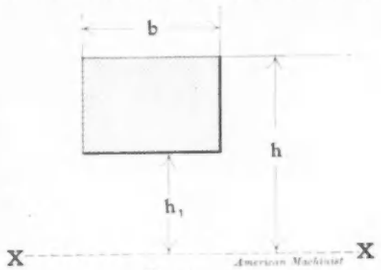

Fig. 1

DIAGRAM SHOWING NOTATION.

$$\frac{(h^3 - h_1^3)\, b}{3} = I$$

in which

b = breadth of element.
h = distance to farthest fiber.
h_1 = distance to nearest fiber.
I = moment of inertia about any axis XX parallel, as in Fig. 1, to the neutral axis.

This formula can be used in the case of any section built up of plates and angles that can be divided into elements bounded by lines perpendicular and parallel to its axis, such as plate and box girders. Other places can be found where it can be used. The only preliminary process is to find the center of gravity of the section, a simple operation that it is necessary to go through in any case.

To illustrate the use of this formula the case of a girder of ordinary box section has been selected. The various calculations to find its properties will be carried out as follows:

To find its center of gravity, or the distance from the extreme top fiber to the horizontal neutral axis,

Its area of cross section = A.

Moment of inertia = I.

Modulus of the section in compression = $Z\,c$.

Modulus of the section in tension = $Z\,t$.

Radius of gyration of the top flange or compression member = R.

These abreviations are standard in their significance.

The section of the girder is shown in Fig. 2. It is symmetrical about its vertical neutral axis; that is, if folded on that axis the two halves would coincide. On account of the difference in thickness of the top and bottom plates it is not divided symmetrically by its horizontal axis, but as this axis passes through the center of gravity of the section, by finding one the position of the other is determined.

To find the center of gravity the principle of moments is used, and the section is regarded as a surface, part of which has been cut out. In this method the area of the sections is divided into convenient parts, and the area of these elements is calculated (on the same principle that is used to find the area of irregular surfaces). Their sum is the total area of the section. An axis of reference is then assumed and the area of each element is multiplied by the distance from this axis to its center of gravity. This result is the moment of that element about the axis of reference, and the total of the moments for all the elements, divided by the total area, gives the distance from the assumed axis to a parallel line passing through the center of gravity of the section. By repeating this operation with an assumed axis at right angles to the first we may find another line passing through the center of gravity, and so determine its exact location, but it is only necessary to do so when the surface dealt with is not symmetrical about any axis.

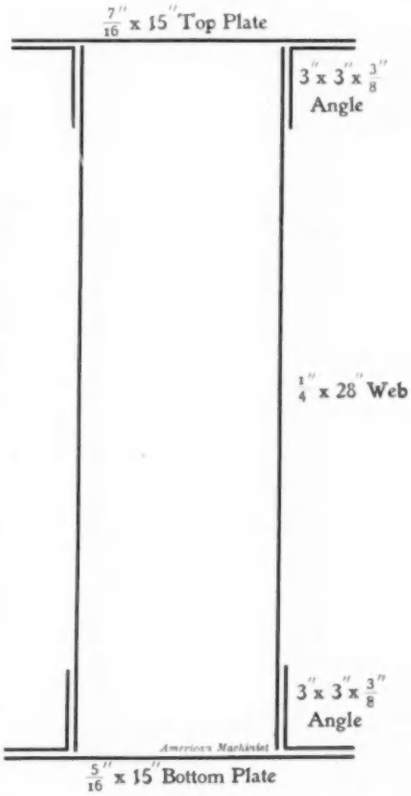

Fig. 2

SECTION OF THE BEAM.

In making the following calculations microscopic accuracy is not attempted,

* The article referred to is "A Simple Derivation of the Formula for the Strength of Beams," by Walter Ferris, published in our issue for April 16, 1896. The article by Mr. Ferris relates to the fundamental formula for simple rectangular beams, which Mr. Dixon takes as proven. —Ed.

only two decimal places being used, but where the third place was five or more, one has been added in the second place. This gives results sufficiently accurate for practice and saves considerable time.

To simplify the work, all the elements on both sides of the vertical axis that are in corresponding positions have been combined, as shown in Fig. 3.

The diameter of the rivet holes is taken as one-eighth inch larger than the rivet, according to standard girder specifications. In this case ⅝ inch rivets are supposed to be used, and ¾ inch is allowed for the holes. This allowance is made in the bottom plate and lowest leg of angle, the worst case. The rivets between the web and angle are staggered with them.

Wherever possible tables have been used to save labor in getting the areas, etc.

The calculation for the area is made as follows:

Depth.		Breadth.		Area.
.44	×	15.00	=	6.56
.38	×	6.5	=	2.44
2.62	×	1.25	=	3.28
22.00	×	.5	=	11.00
2.62	×	1.25	=	3.28
.38	×	5.00	=	1.88
.31	×	13.5	=	4.22

Total area, 32.66

The next operation is to find the moment of each element about an axis of reference, and the top edge of the section is selected, on account of its convenience. The first column of the second table contains the areas previously found. The column of multipliers contains the distances from the top of the section to the neutral axis of each area; that is, the distance between the center of gravity of each element and the assumed axis of reference. The third column contains the moments obtained by performing the indicated multiplication.

Areas		Distance from axis to center of gravity of elements.		Moments.
6.56	×	.22	=	1.44
2.44	×	.63	=	1.54
3.28	×	2.13	=	6.99
11.00	×	14.44	=	158.84
3.28	×	26.75	=	87.74
1.88	×	28.25	=	53.11
4.22	×	28.59	=	120.65

Total moment about top of section..... 430.31

The total moment divided by the total area gives the distance between the assumed axis and the center of gravity or neutral axis of the section parallel to it:

$$\frac{430.31}{32.66} = 13.175$$

Taking this as 13.18 inches, the distance from the top of section to its neutral axis, the formula in the first part of this article comes into play. The breadth of each element of the section is to be multiplied by the difference of the cubes of the distance in inches to its outside fibers farthest from and nearest to the neutral axis of the section respectively. This result divided by three is the moment of inertia of the element around

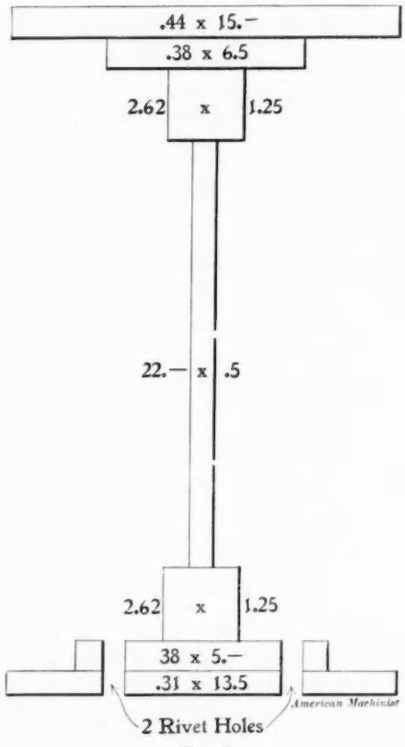

Fig. 3

COMBINATION OF ELEMENTS.

the neutral axis of the section. The sum of the moments of inertia of all the elements is the moment of inertia of the section.

To abbreviate the work as much as possible, the operations indicated in the numerator of the formula are successively performed, and the sum of the results obtained is divided by three. This gives just the same result as if each fraction had been reduced to its lowest terms before addition.

The cubes of the various numbers were obtained by using logarithms, but this labor can be avoided by using Barlow's tables, which give the square, square root, cube, cube root and reciprocal of all numbers from 1 to 10,000. The ordinary tables running to 1,000 are only of use when h and h_1 are less than 10 inches, as they very rarely come out in even tenths of an inch.

h^3	h_1^3	
13.18^3	12.74^3	= 211
12.74^3	12.36^3	= 180
12.36^3	9.74^3	= 964
9.74^3		= 924
12.26^3		= 1843
14.88^3	12.26^3	= 1437
15.26^3	14.88^3	= 270
15.57^3	15.26^3	= 221

No decimals are used here, as commercial accuracy is obtained with less labor by their omission.

$(h^3 - h_1^3)$	b	
211	× 15.00	= 3165.00
180	× 6.50	= 1170.00
964	× 1.25	= 1205.00
924	× .50	= 462.00
1843	× .50	= 921.50
1437	× 1.25	= 1796.25
270	× 5.00	= 1350.00
221	× 13.50	= 2983.50

3)13053.25

$4351.1 = I$

The modulus of the section is found by dividing the moment of inertia by the distance from the neutral axis to the extreme fibers of the section. For symmetrical sections it is the same for compression and tension. The formula is:

$$Z c = \frac{I}{\text{Distance to extreme fiber in compression.}}$$

$$Z t = \frac{I}{\text{Distance to extreme fiber in tension.}}$$

Substituting in these equations the values already found gives

$$Z c = \frac{4351.1}{13.18} = 330.13$$

$$Z t = \frac{4351.1}{15.57} = 279.45$$

Total depth of section..... 28.75
Neutral axis to top..... 13.18

Neutral axis to bottom..... 15.57

The modulus of the section is important, and is used in determining the transverse strength of the beam or the load it is capable of sustaining with the specified fiber stresses.

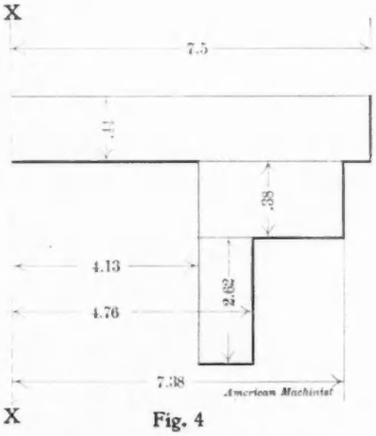

Fig. 4

ONE HALF OF TOP FLANGE.

For the best distribution of material:

$$\frac{\text{Total bending moment}}{f c} = Z c$$

$$\frac{\text{Total bending moment}}{f t} = Z t$$

in which

$f c$ = extreme fiber stress in compression.

$f t$ = extreme fiber stress in tension.

In practice it is the endeavor to closely

approximate these results.

This formula can also be used to find the resulting fiber stress for a total bending moment, as follows:

$$\frac{\text{Total bending moment}}{Z\,c \text{ (or } Z\,t)} = f\,c \text{ (or } f\,t)$$

The lateral stiffness of the girder is dependent on its top flange or compression member, which acts like a column, and is found by dividing the length in inches of the girder between its points of support by the radius of gyration of the top flange about the vertical axis of symmetry. This ratio limits the permissible fiber stress in compression. The larger the ratio the less the fiber stress allowed. On this account it is desirable to have as large a radius of gyration as can be attained economically.

The general formula for the radius of gyration is

$$R = \sqrt{\frac{I}{\text{Area}}}$$

Considering the top flange only, values are to be found and substituted in this formula.

To find the area the areas of the top plate, the two top angles and the adjacent web plate are taken from previous calculations.

6.56 Top plate.
2.44 } Top angles and web.
3.28 }

12.28 = Area top flange.

The value of I is found, as previously shown, but as the top flange is symmetrical about its vertical axis, the calculation is only made for one-half and multiplied by 2. See Fig. 4, which reproduces on a larger scale one-half of the top flange of Fig. 1.

$$7.5^3 = 421$$
$$7.38^3 - 4.13^3 = 332$$
$$4.76^3 - 4.13^3 = 38$$
$$421 \times .44 = 185.24$$
$$332 \times .38 = 126.16$$
$$38 \times 2.62 = 99.56$$
$$3)\,410.96$$
$$136.99$$
$$2$$
$$273.98 = I$$

Substituting these values in the formula and performing the indicated operations.

$$R = \sqrt{\frac{273.98}{12.28}} = 4.72 +$$

In the foregoing all dimensions are in inches, but it makes no difference what unit is selected, provided it is adhered to throughout. The endeavor has been to make all explanations as simple and clear as possible, and it is hoped this result has been attained.

▲ ▲ ▲

A factory to build the De Dion gasoline motor vehicles is projected, to be located in Orange, N. J.

Letters from Practical Men.

Steam Driven Road Carriages.

Editor American Machinist:

The description of the Boston steam carriages by John Randol in your paper of December 1, 1898, makes but scant mention of the labors of my good friend, the late Sylvester H. Roper, and your types have made him Roger.

A machinist in Brattleboro, Vt., by the name of John Gore, made about fifty years ago the first steam carriage in this country of which I have any knowledge. I never saw it on the road, but there were some pieces in Gore's shop, where I was a frequent visitor forty-five years ago, being then a student in the academy at Brattleboro. The boiler was made up with copper tubes bent to a U form.

The hills, rocks and mud of Vermont were not well fitted for steam carriages, and when out on the road one day, in turning out for a team, it went a little too far and rolled down the bank, stopping in the brush with the wheels in the air and Gore underneath. After awhile he came crawling up the bank and, when near the top, looked back on the wreck, with the remark, "I guess your d——d old smoke pipe got jammed that time!" Ordinarily Gore was a fluent swearer, but this disaster was too much for his linguistic powers, and the engine was never rebuilt.

Roper's first steam carriage was built about thirty-three years ago, and the last about fifteen. Both I have seen, but there must have been several between, including the steam velocipede with wooden wheels and frame. His last work was fitting a boiler and engine between the wheels of an ordinary Columbia bicycle with air tires (you may use the word "pneumatic" if you prefer), and he found that in running over a certain road about ten miles the new machine used twice the quantity of water as the old velocipede. We had a good deal of discussion over this, and decided that the doubled evaporation and doubled power required for the modern bicycle must be due to inelastic action of the air tires, which produced something like a continuous mud track. The old velocipede had wheels of somewhat larger diameter and steel tires.

This brings me to the assertion that the present motor carriage wheel is far inferior to what it might be with our present facilities. Look at the wheels in your picture (page 898)—a hundred delicate pieces in each—and think what a trifle of mud or rust will do to all those little pieces, and again at the gum tires filled with compressed air, which, as everyday experience with bicycles proves, will find ways of getting out.

I am very familiar with the Whitney buggy mentioned by Mr. Randol. It does not differ much in appearance from the pictures you have shown of the Mason machine, and both are inferior, in my opinion, to Roper's of fifteen years ago.

Roper's buggy was made of hickory wood, though I would prefer steel, with four spoked wheels, steel tires, springs and an upright boiler 12 inches diameter and 18 inches high, with internal furnace and tubes. It was fired with Cumberland coal, and, blowing the fire by the exhaust, he could run 10 miles without looking at the fire, and the steam and smoke were invisible.

It seems curious that I should be writing a defense of such a well-known and simple method as this for steam making.

Whitney makes a beautiful fire with his gasoline and burners, but the noise of it is quite as much as need be from an exhaust, and I noticed that horses were frequently startled by a trifling show of cloud from the exhaust between the wheels; but I would go a long way around before I would recommend anyone to fool with gasoline. Whitney, of course, can use any fuel he pleases.

Roper always insisted that the carriage should have four wheels, his reason being that the following wheels tracking in the hardened rut made by the leading wheels should make less resistance than three wheels making three new ruts. For all that I would prefer the three wheeler for its simple construction. Whitney has gone into the matter of the twisting axles very thoroughly. Mason's pictures show apparently no provision for any unevenness on the road.

I have ridden with Whitney over the worst hills in East Boston. The control he has is perfect and the speed unlimited over a tolerably level ground and with a clear track.

I come now to the differential motion for the drive wheels, which I consider an unnecessary and possibly an injurious attachment. Roper held that with wheels rigidly connected the machine would try to run straight, and requires less care in steering than when the wheels are independent and the machine always trying to run crooked. Still it very likely is, as Whitney says, that the great adhesion of the gum tires to the road makes turning more difficult if the wheels are rigid, and the gum more likely to be torn up by sliding.

In the present state of my knowledge, which I confess is but slight as compared with what George Whitney has actually done, I would lay out a steam buggy with three wheels, 4 or 5 feet diameter, with angle steel rims and sheet steel circles stiffened with wood to prevent noise.

I would use a boiler with liberal water capacity, and fire with soft coal, or anthracite with the slates picked out, and I would use lots of gum springs instead of gum tires. WILLIAM H. HARRISON.

Braintree, Mass.

Cost of Feeding a Boiler.

Editor American Machinist:

In an article on this subject, in the "American Machinist" of October 20, the question is raised by Mr. Tecumseh Swift as to whether a boiler can be fed for nothing. Referring to the apparatus, Fig. 1, the action of which gives rise to this question, *A* is the boiler, *B* a vessel connected to *A* by two cocks, 1 and 2, and at a hight relative to the water level *a*, as shown, while *C* is a tank holding water and communicating with the source of supply by a pipe *D* through a clack-valve 4, and connected to *B* by the

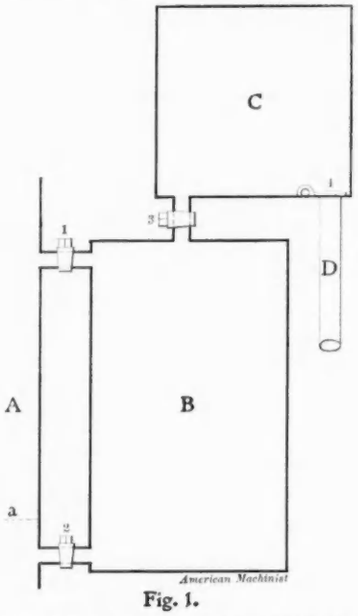

Fig. 1.

TECUMSEH SWIFT'S SUGGESTION FOR BOILER FEEDING.

valve 3. *B* being full of steam, and 1 and 2 shut, if 3 is opened water enters and is condensed till *B* is full, the displaced water in *C* being made good by the entry of an equal quantity of water from the source of supply. Now, on shutting 3 and opening 1 and 2, the water drains to the boiler by gravity and the cycle of operations can be repeated at pleasure.

The question of importance is to find out the relationship between the heat existing in the steam in the vessel *B*, the work done, and the heat restored again to the boiler. The full answer to this question requires a little patience, and will be evolved more easily by making our notions more definite by certain suppositions as to the temperature, pressure, and so on. Let us, therefore, assume that the steam in the boiler *A* is dry, but not superheated, at a pressure of 130 pounds absolute, and that the temperature of the feed water is 32° Fahr. Further, suppose that the vessel *B* is an absolute non-conductor and without capacity for heat; that is, let it be granted that no heat can be imparted to it, passed through it, or taken from it.

The volume of *B* may conveniently be assumed to be such that it will hold 1 pound of steam at 347° Fahr.; that is, it should contain about 3.36 cubic feet. Now, let us follow what has happened during the formation of a pound of steam, from the initial stage in which it existed in the form of water at 32 degrees.

At that temperature it occupied a volume of about .016 cubic foot, and the first stage of the process consisted in raising the temperature from 32 degrees to 347 degrees. During the process some 319 heat units were imparted to the water; that is to say, an amount of heat whose mechanical equivalent is 246,300 foot pounds was gained. The next stage was evaporation, and it must be noted that the evaporation took place under a constant pressure of 130 pounds per square inch. During this process it received heat to the extent of 670,700 foot pounds; part of this, however, was heat which was expended in doing external work—that is, in pushing away steam surrounding it at a pressure of 130 pounds per square inch.

This may be more clearly seen by supposing that the water is evaporated in a vessel, Fig. 2, fitted with a piston *B* of one square foot area. Now as evaporation is to take place under a load of 130 pounds per square inch, the piston must be weighted with 130x144 pounds, say 18,720 pounds, and during the process of evaporation the piston is pushed up 3.36 — .016 feet, say 3.344 feet. External work has been done therefore, and heat has been required for this purpose, which is equivalent to nearly 63,000 foot pounds. The reason for noting this point rather carefully will be recognized later.

So far we have seen that it costs an amount of heat equivalent to 917,000 foot pounds to change a pound of water in the boiler into a pound of steam at 130 pounds pressure, occupying the reservoir *B*. Now, during the process of condensation, 209 pounds of water will enter the vessel *B*, since 3.36 cubic feet contain about 210 pounds of water at temperatures near those assumed.

The temperature of the incoming water is raised from 32 degrees to a temperature depending upon the amount of heat imparted to it by the condensed steam. Now, the heat which is given up in condensing a quantity of steam will be only the same as the heat given to the steam in process of formation, under one condition, viz.: that the external work done on the steam during condensation is the same as that done by the steam (and paid for by heat supplied) during formation. It remains then to see how much work can be externally done on the steam during condensation. Referring to Fig. 2, it is obvious that under the most favorable conditions—viz., when the water can enter by gravity alone into the interior of *A* (*B* being now supposed locked at its highest position)—the amount of work done by the atmosphere in collapsing on the space occupied by the steam will be the same as if the piston descended with a load equivalent to 2,116 pounds per square foot; *i. e.*, 14.7 pounds per square inch), for 3.34 feet, *i. e.*, about 7,067 foot pounds. It, therefore, follows that the heat restored to the boiler is less than that originally supplied to the steam used by just the amount of difference between the heat expended in external work during the formation of the steam and the amount of external work done on the steam during condensation.

In the example cited, the difference amounts to 63,000 — 7,067 foot pounds, or in round numbers 56,000 foot pounds, or in heat units 72.5. The total heat of evaporation in heat units being 1,188, we see that the cost of the operation is 6.1 per cent. of the heat of formation of the steam used, 93.9 per cent. of the heat being utilized in heating the feed water. Moreover, about 209 pounds of water having been fed into the boiler, it will be seen that the cost per pound of water fed into the boiler is about .346 of a British thermal unit.

It may be of interest to push the inquiry a stage further and ascertain what is the effect of increased boiler pressure in the economy of boiler feeding by this method. Stated in general terms, if $V =$ volume of 1 pound of saturated steam in cubic feet under pressure of P pounds

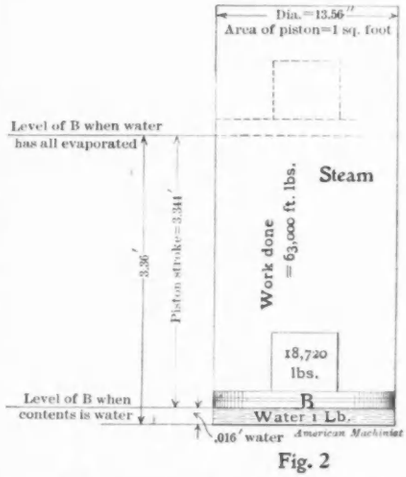

Fig. 2

HOW EXTERNAL WORK IS DONE IN EVAPORATING 1 POUND OF WATER.

per square foot, and $S =$ the volume of 1 pound of water in cubic feet, then the increase of volume during steam formation is $V - s$ cubic feet, and the external work done is $P\ V - s$ foot pounds.

Now, in condensing at atmospheric pressure the external work done on the steam is $V - s$ 2,116 foot pounds (2,116 being the normal atmospheric pressure per square foot). So that the difference between the external work of formation and condensation is $P - 2{,}116\ (V - s)$ foot pounds. Now, the amount of water

which is sucked up during condensation is obviously $(V - s)$ cubic feet, or 62.5 $(V - s)$ pounds. Hence the cost of feeding 1 pound to the boiler is

$$\frac{(P - 2{,}116) \times (V - s)}{62.5\ (V - s)}$$

foot pounds, or

$$\frac{(P - 2{,}116)}{62.5 \times 772}$$

heat units.

If P = absolute pressure in pounds per square inch and G = gage pressure in pounds per square inch, then heat units used per pound of water fed into the boiler

$$\frac{(P - 14.7)\ 144}{62.5 \times 772} = \frac{G}{335}$$

nearly, showing that the cost of feeding the boiler advances directly as the gage pressure.

Now, supposing the water had been introduced by any form of pump, 1

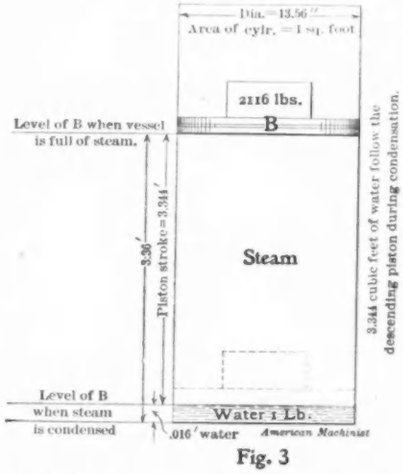
Dia. = 13.56"
Area of cylr. = 1 sq. foot
2116 lbs.
B
Level of B when vessel is full of steam.
Steam
3.36'
Piston stroke = 3.344'
3.344 cubic feet of water follow the descending piston during condensation.
Level of B when steam is condensed
Water 1 Lb.
.016' water
American Machinist

Fig. 3

EXTERNAL WORK DONE BY ATMOSPHERE DURING CONDENSATION.

pound of water will occupy a volume of $\frac{1}{62.5}$ of a cubic foot, and introducing it into the boiler against a force of G pounds per square inch, or $P - 2{,}116$ pounds per square foot, work must be done to the extent of $\frac{P - 2116}{62.5}$ foot pounds or $\frac{G \times 144}{62.5}$ foot pounds, the equivalent of which in thermal units is $\frac{G \times 144}{62.5 \times 772} = \frac{G}{335}$

So that the amount of heat disappearing is the thermal equivalent of the amount of work that would be done by a pump in introducing the water into the boiler.

The last statement shows that in its ideal form the apparatus is as economical as is possible; a more economical arrangement would be capable of achieving perpetual motion. It is, however, pertinent to ask if the arrangement is superior to an injector. Here also the only heat lost by the system is that lost by radiation and that needed for the performance of the work actually necessary to introduce the water against the pressure of the boiler. It is not the purpose of this article to raise other questions, which naturally present themselves, as to whether the injector, which is theoretically equally good, is not practically very much better than any existing apparatus based on the principles enunciated.

It only remains to examine the claims of such an apparatus as a feed heater. In the numerical example quoted 1 pound of steam imparts all of its heat of formation from water at 32°) except 72.5 thermal units, to 209 pounds of the incoming water at 32. Let T be the temperature of the mixture, then $(T - 32°)\ 210 = 1188$ or $T° = 32 + \frac{1188}{210} = 37.65°$, or the water is only raised about 5.65° Fahr.

Comparing this with a good injector it would be found that in the latter 1 pound of steam would be used for every 18 pounds of water fed into the boiler; the heat equivalent of the work done in introducing this 18 pounds of water is, in thermal units $\frac{18 \times G}{335}$, and if $G = 115.3$, as in the numerical example, where absolute pressure = 130, and therefore $G = 130 - 14.7$, heat lost $= \frac{115.3 \times 18}{335} = 6.192$.

The heat available in the pound of steam is therefore 1,188 — 6 nearly, or say 1,182 thermal units. The temperature of the mixture being t, and losses such as radiation being neglected $(t - 32)$, $19 = 1{,}182$ or $t = 32 + 62 = 94°$ Fahr., nearly. The rise of temperature is therefore $94° - 32° = 62°$, as compared with 5.65° in the previous example. The injector is therefore altogether superior as a feed heater. Finally, it has been assumed that the water supply was on a mean level with the boiler level. Had it been assumed to be lower it will be evident that the heat restored during condensation would be less, since condensation would then take place under a pressure of the atmosphere, less a pressure due to the head of water, with the result that additional heat would be absorbed in doing an additional amount of work, and less heat would be available for heating the feed water, the equivalence being maintained.

ROBERT A. BRUCE.

New Brompton, Kent, England.

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Boring a Big Wheel on a Small Lathe.

Editor American Machinist:

Seeing the inquiry of E. T. O., November 17, as to boring 48-inch wheels on a 20-inch lathe recalled to my mind the manner of doing practically the same thing in a shop where I was once employed. As I write from memory the sizes given may not be accurate. The job was boring and facing the hubs of 60-inch chain wheels for a hoist, and the tool used was a 20-inch hollow spindle lathe, the hole through the spindle being about 2 inches diameter. Our method was simply to take off the head and reverse it, bolting it again to the bed, so that the face plate overhung the end. In this case the bolt holes lined up all right, but if not the head could easily have been clamped in place. Four arms of cast iron, each about 1½x6x30 inches long, were then bolted to the face plate, and the chain wheel was clamped to these by the rim and set to run through.

The boring of the hole was done with an ordinary boring bar and cutters, the bar, 1¾ inches in diameter, passing through the hollow spindle, and being supported at the end nearest chain wheel by a bushing fitted to the spindle in place of the live center. The other end of the bar was clamped in a V block on the compound rest, which, being turned so that the tool post slot stood at right angles to ways of lathe bed, allowed a bolt on each side of bar and a strap over it. Care, of course, was taken to have the rear end of bar centered properly. The usual carriage feed was employed, a wooden disk or pulley being clamped to a gear on the splined rod and driven by a belt from the face plate hub. A cross belt in place of the usual straight belt from the counter shaft to the head completed the changes required.

The facing of the hubs was accomplished by the use of ordinary facing cutters, one end being faced at the same setting and the wheel reversed for facing the other end. As the cutting were rather hard the scale was broken with the aid of hammer and chisel before the facing cutters were applied. If the arms were too light to stand the cut when the wheel was clamped by the rim it could as easily be clamped by the arms near the hub, which, I believe, would be the better way.

C. W. PITMAN.

Philadelphia, Pa.

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Technical Publications.

SOME EXPERIENCE WITH AN INTERNAL COMBUSTION MOTOR. By W. L. Garrels, 4531 West Pine Boulevard, St. Louis, Mo.

This is a pamphlet which is rather remarkable. It is devoted to a comparison between the claims made for the Priestman Oil Engine by its builders and others, and the actual experience of the author and his partner, Mr. S. E. Freeman, in installing one of them and endeavoring to get it to run satisfactorily. The contrast as presented by the pamphlet is a very strong one, but the author touches very lightly on the technicalities of the subject—that is to say, there is practically nothing to show why the engine did not work well nor how the difficulties experienced with it might have been overcome.

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The Promoters of Engineering Progress.

The annual address of the retiring president of the American Society of Mechanical Engineers was this year a departure from recent practice. It has been the custom to select, as the topic of discourse upon these occasions, some purely and often narrowly technical subject, and usually one in line with the special experience of the speaker. Thus Mr. Warner's address of last year was upon modern telescopes; Mr. Fritz spoke of a large lathe and other machine tools and practice at the Bethlehem Iron Works; Mr. Billings had drop hammers and drop forgings for his subject; Mr. Eckly B. Coxe discoursed upon coal, and so on. So Mr. Hunt might have prepared an instructive and interesting disquisition upon hoisting and conveying machinery, but probably none of the members of the society, nor the mechanical world at large, will regret that a different theme was chosen.

The development and progress of the work of the mechanical engineer in the world was not to be handled in a small way, and it was not. The most valuable feature of the address was in its suggestiveness. Doubtless there were few who heard it, or who have read it, that were not provoked to think beyond the points to which the words actually carried them. We may perhaps venture here to touch lightly upon a single line along which we were driven by the momentum which the speaker imparted.

Progress in engineering knowledge and achievement has been in this century, and especially in the latter half of it, at a pace scarcely comparable with anything in the previous history of the world. The agencies of this modern progress have not been different in kind from those of all the ages. Our knowledge has still grown by accumulation. One thing has led to another, and each notable discovery and each great thing done has stimulated to more penetrating investigation and more fruitful effort. The more rapid growth of recent years is clearly traceable to the greater facilities which have developed for the old and only means of progress, the diffusion among the many of the ideas of the more advanced few, and the universally accessible records of the means and methods employed by those most successful.

Among these modern means of information and stimulus we are not in the least disposed to belittle the scientific societies. It is all right, from his viewpoint, to find the president of one of these societies describing their work as follows:

"The advance made in the accumulation of useful data and more accurate knowledge in practical engineering gained one season is presented to a scientific society the next, and still later it will be embodied in text books for the instruction of students who are soon to take our places and carry on our work. Until attention is called to the subject, we are not likely to realize that in their essential parts the great bulk of the engineering data available to us now have been first presented to a scientific society, and there permanently preserved until the time came for their utilization or application. It is this great fund of information, principally accumulated during the last century, that we draw upon for the materials for our text books, our general treatises and our engineering handbooks."

From our standpoint, however, which we need not say is necessarily a very different one, it seems imperative upon us to challenge this statement of the function of the scientific society. It must really be much overstated. "The great bulk of the engineering data available to us now" has not to this day gone upon record in the transactions of any society. "The material for our text books, our general treatises and our engineering handbooks" has some of it come from the societies, but vastly more from other sources. The societies do an excellent work, and a work of their own, but they are far from being, as we might infer from the above quotation, the only existing agency of engineering progress. We must be permitted to question if they are, indeed, the chief agency. If the scientific society may truly boast that it is a modern institution, and a highly useful and successful one, the technical periodical is somewhat younger and not less powerful and valuable. The society has its annual or its semi-annual meetings, its annual volume of transactions, its score or so of valuable papers of practical application and its restricted membership. The technical publication is a weekly or a monthly visitor, its topics are numerous and as all embracing as the profession to which it ministers; it, rather than the society, presents to its world the newest discoveries, inventions and achievements, with superadded criticism and suggestion; its audience is usually easily tenfold the society membership, and all may join it who will. All that is valuable and really important in the society transactions these technical publications are the first to distribute, and through them only is full publicity obtained. The societies give to their membership full value for the fees received, but how vastly greater is the return to the subscriber of the true and faithful technical journal. If the society member may regard his connection with the institution with pride and satisfaction, the subscriber to the good periodical may surely flatter himself that he also is one of a great company, and that he certainly will receive manifold equivalent from his investment.

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Smokeless Combustion of Soft Coal.

In the December number of "Locomotive Engineering" its editor, Angus Sinclair, gives an account of what is now being done on the Burlington, Cedar Rapids & Northern Railway in the matter of the smokeless combustion of soft or bituminous coal. Formerly the locomotives of this road had smoked as freely as locomotives usually do where soft coal is used, and this coal smoke had, in fact, become a serious handicap to the road in its passenger business. About a year ago General Superintendent Robert Williams decided to attempt a remedy, and in doing so called in as an assistant a friend of his, Mr. Richard Newsam, an owner of soft coal mines and a believer in the doctrine that under proper conditions, and with reasonable care in firing, soft coal can be fired with almost no smoke. He insisted that in this case it was only necessary to adopt the plan of firing very small charges of coal—at most, not over two shovelfuls, and preferably only one. The engine men, as might be expected, were not easily convinced that this could be done, and finally Mr. Newsam fired a few trips himself to demonstrate that it could be done. After this it was easy for Mr. Williams to secure the hearty cooperation of a large proportion of the men, with the result that where formerly dense clouds of smoke marked the line of the road there is now practically none.

and, moreover, there has been a very considerable reduction in the consumption of coal doing the same and, in some cases, even heavier work. This has involved no change whatever except in the manner of firing and a little additional care and attention on the part of the engineers, especially in managing the injector and in starting out of stations. A good portion of the service, both passenger and freight, is heavy, and locomotives have to be "hammered" for all they are worth. They now pass some coaling stations without coaling, where formerly it was always necessary to stop and take coal.

Everyone who has anything to do with the firing of soft coal, or who lives in a city cursed with a pall of black smoke, should read this record of what has been done in a case which seemed particularly difficult, and especially every manufacturer who has been made to believe that the black clouds poured out by his smokestacks are unavoidable should read it.

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To Regulate Express Charges.

It is proper for us to call attention to an important work which has been begun by the Merchants' Association of New York, and which must be of direct and constant interest to a large proportion of our readers. There are not many who do not have occasion to employ the services of some of the various express companies, and most must do this quite extensively. There are also not many who really enjoy paying much more than what is equitable and right for the services rendered. The association above referred to has collected information concerning express rates, and has prepared them for presentation to the public. The results brought out are most astonishing. Freight rates are not such that as a rule the carriers under them lost money right along, but comparing express schedules with them, it appears that the express charges run up to from 300 to 20,000 per cent. above the corresponding freight charges, and that for many classes of goods the charges average from 5 to 15 per cent. of the value of the merchandise transported. The information in this line has been collected and put in form for general distribution, and the association will be only too glad to send the same whenever they have the opportunity.

The express companies are uncontrolled by law and make their own rates, which their victims are compelled to pay. The Merchants' Association of New York has undertaken to bring the companies under such control as to ensure reasonable rates, and they ask the support and cooperation of the public. They will introduce a "Bill to Regulate Express Companies" at the next session of the Legislature of New York, and to secure the passage of such a bill they ask for united action by the shippers to demonstrate that present charges are exorbitant, to pledge Assemblymen and Senators to support a reform measure, and to enlist the support of the local press throughout the State. Information will be furnished, with memorials to be signed, upon application to the Merchants' Association of New York, Broadway and Leonard street, New York.

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New Quarters of "Locomotive Engineering"—A Request to Subscribers.

Last week we stated that our friends of "Locomotive Engineering" had found a temporary lodgement with us after the loss of their own office by fire. They have now secured permanent quarters at No. 95 Liberty street, New York.

Their latest revised mailing list was destroyed by the fire and they request all their readers to send in their addresses with the date of their subscriptions or of expiration.

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Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer by mail.

(121) "Subscriber," Anaconda, Mon., asks how to find the weight necessary to hang on the string to support the cylinder shown in Fig. 1 in any angular position. The cylinder is supported at its lower end by trunnions. A.—Proceed as shown in Fig. 2, in which *a b* is the center line of the body in the position desired, *c* being the point of attachment of the string and *c d* the direction of the string for the position *a b* of the cylinder. Find the center of gravity, *e*, of the cylinder—in this case the center of length—draw *e f* to scale to represent the weight of the cylinder, and at *c* construct the parallelogram of forces *e g f h*, *e g* being the prolongation of *e i*, which is parallel to *c d*, and *f g* being parallel to *a b*. The line *e g* now represents the pull on the string if it were applied at *c* and had the direction *e i*. To find the pull on the actual string draw *a j* perpendicular to *c d* and *e i*. Make *j k* equal to *a l* and *l m* equal to *e g*. Draw *j m* and *k n* will be the pull required.

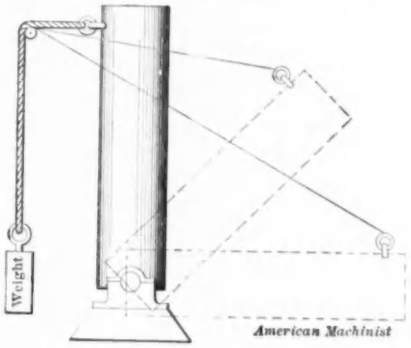

Fig. 1

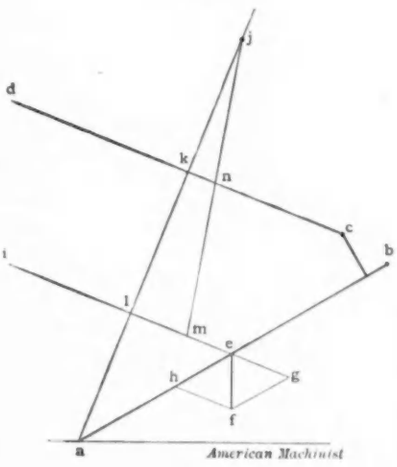

Fig. 2

(122) C. L., Brooklyn, N. Y., writes: Suppose, first, we have two hammers, arranged as in Fig. 1, each moving through a space of 6 feet and giving a 100-pound blow, and a piece of work between them, say, a piece of wrought iron; and, suppose again, we take away one of the hammers, as in Fig. 2, and substitute a heavy anvil, properly secured as in a steam hammer. Would the blow be 200 pounds on the piece of wrought iron in the first case and only 100 pounds in the second one, or would the blows be the same in both cases? A.—This is a question on which anyone may be excused for getting confused. We should, however, begin our answer by saying that the blow of a given hammer cannot be measured in pounds only. Blows are measured in foot pounds, not in pounds. It is obvious enough that a hammer falling on a feather bed would produce much less actual pressure than if falling on an anvil, while the work done—that is, the foot pounds of energy of the blow—must be the same in both cases, since the hammer has the same amount of dynamic energy in both cases, and this energy is the foot pounds of the blow. In other words, while there is a pressure on

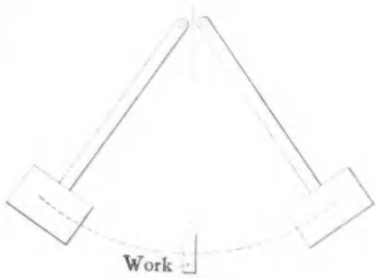

Fig. 1.

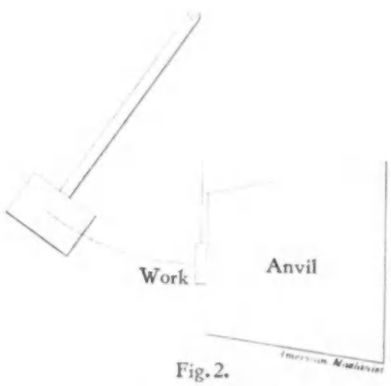

Fig. 2.

the work which can be measured in pounds, the intensity of this pressure depends on the compressibility of the piece under the hammer quite as much as on the weight and velocity of the hammer. Thus we can say that a given hammer falling a given distance delivers a blow of a definite number of foot pounds, but we cannot say what the actual pressure on the work in pounds is unless we know the amount which the work has been compressed in destroying the energy of the blow, the same amount of energy being made up of small pressure and large distance with a soft piece of work and of heavy pressure and small distance with a hard piece of work. With a piece of hot iron on the anvil the force is small and the compression great at first, but as the iron cools off the compression becomes less and the pressure greater. Turning now to the question, it is clear that the energy of the two hammers in Fig. 1 is twice that of the single hammer in Fig. 2, but nevertheless action and reaction are equal, so that with work of the same hardness the pressure on the work will be the same in both cases, but there being twice the energy to be destroyed in Fig. 1 the work in that case will be compressed twice as much as in Fig. 2. Perhaps the matter can be made clearer by supposing the work to be a spring, which for convenience we will further suppose to be of a definite strength which does not increase with its compression. With either arrangement the pressure would be the same, since it must be equal the strength of the spring and can be no more, but with the arrangement of Fig 1 the spring will be compressed twice as much as with Fig. 2.

(123) J. W. O., Niles, N. Y., asks for a rule for finding the area of a segment of a circle. A.—

Let a = the length of the cord
b = the rise of the segment
c = the radius.

Then

$$\text{Area of segment} = (a \times b)\,(.6854 + \frac{1}{10}\left(\frac{b}{r}\right)^2$$

If the segment exceeds half of the circle, as in the case of the water space of a cylindrical boiler, find the area of the smaller segment or steam space and subtract it from the area of the entire circle. We believe the above is the simplest formula for the area of segments, provided, as is desirable, the area is to be found from straight lines which can be measured. By introducing the length of the arc the formula can be made simpler in appearance, but not in fact, since the length of the arc cannot be measured, but must be found by calculation before it can be substituted in the formula If you have much of this work to do you will find it much more satisfactory to use a table of areas of segments which can be found in any engineer's pocket book.

(124) J. L. A., Hamilton, Ont., asks: In making pistons for gas engines, what is the best material for rings and how are they fitted? Is the piston made a close fit, or is it slack and the rings depended on to make it gas tight? Are the rings usually placed singly in each groove, and if so, why? Would not two rings in each groove with the split sides diametrically opposite be good? A.—We have looked into the practice of the De La Vergne Refrigerating Machine Company, of this city, in their construction of the Hornsby-Akroyd gas engine. By the kindness of Mr. George Richmond, of that company, we were lately permitted to examine a 16-inch cylinder and piston belonging to an engine which had been running three years. The cylinder, trunk piston and rings were of cast iron. The rings, of which there were four, placed, of course, near the inner end of the piston, were about ⅝ of an inch wide, and each sprung into a separate groove, with about ½ an inch between the grooves. The ends of the rings had each a rectangular projection one-half the width of the ring, one on one side and the other on the other side, lapping by each other and the ends coming very close together when the ring was in position in the cylinder. The piston was fitted to just slip into the cylinder. It was understood that in boring the cylinder it was made slightly larger at the inner end near the combustion chamber to allow for the effects of the heat. Some experience must, of course, be necessary to secure precisely what is best in these conditions. The wear shown in the cylinder examined was quite small. Where the rings had traveled, the marks of the boring tool had disappeared on the lower side of the cylinder, while on the upper side they were not all obliterated, and the entire surface showed a beautiful glaze without scratch or cut. The wear was less than we would have expected to see in a steam cylinder after running as long. Two rings in a groove have, of course, been tried, but the single ring in each groove seems to have prevailed.

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Opening of Purdue Lecture Course.

The first lecture of the Purdue Railway course, for the season of 1898-9, was given on November 9th, by Dr. Charles B. Dudley, chief chemist of the Pennsylvania Railroad. Dr. Dudley's subject was "The Relation of Chemistry to the Railroad." The speaker first gave some interesting figures on the amounts of money spent by the railroads for various materials, which very forcibly illustrated the immense importance of the departments of chemical and physical testing and inspection. He said that the purchasing agent of the Pennsylvania Railroad spends from $17,000,000 to $20,000,000 a year, and of that amount about $5,000 goes for rubber bands, $7,000 for lead pencils, $1,000 for pins, $5,000 for ink, $2,000 for toilet soap, $1,000,000 for lumber, $60,000 for hose, and called attention to the very interesting fact that it costs nearly as much for stationery with which to carry on the business of the road as it does for iron. The duties and responsibilities of the inspector were then described and his work illustrated by reference to numerous actual cases. Dr. Dudley took up the subject of specifications and showed how they are built up and the methods of obtaining the information from which they are compiled. As an illustration he gave in detail the Pennsylvania Railroad specification for car axles. These specifications contain not only information for the guidance of the manufacturer, but as well for the purchasing agent, inspector and tester. He showed that it was the duty of the chemist not only to write specifications and test materials, but to investigate special problems on a great variety of subjects and related many instances from his own broad experience which showed the wide range of information and ingenious application of new methods which have been called into play in the solution of these various problems which have arisen from time to time.

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Compressed Air in Naval Vessels.

A resolution has been introduced in the Senate asking that the Committee on Naval Affairs be authorized and directed to inquire into and report upon the merits of the pneumatic and other systems to be introduced into the new vessels of the navy, with a view to ascertaining whether it will be advisable to introduce the pneumatic system into the proposed new battleships. In submitting this resolution, Senator Chandler calls attention to the fact that the durability and efficiency of this system was proven under severe tests upon the monitor Terror during our late naval battles. The system has been recommended by Capt. T. F. Harrington and Capt. Nicoll Ludlow, both of whom have commanded the Terror, and the former gentleman suggests that this system and such machinery of the new battleships as it is proposed to operate by electricity shall be tried in competition on two battleships in order that the Government may have the benefit of the results.

The compressed air system as used on the Terror is the only power that has been used in any navy as a complete system for all of the operations of checking the recoil of the guns and returning the same to battery, their elevation and depression, the cleansing and cooling of the guns, the manipulation of the breech mechanism, the revolving of the turrets, the hoisting and ramming of the ammunition and the steering of the ship, and is the only power that can be applied as a complete system for these operations, as well as for working anchors, hoisting, ventilating the ship, refrigerating, etc.

A. F. T.

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Remarkable Metal Working.

Editor American Machinist:

The writer lately saw what is either a remarkable discovery in the art of metal working or an equally remarkable "fake."

Only exhibits were shown, and these were supported by the discoverer's statement alone, which, if true, will lead to most wonderful changes in working copper, aluminum and alloys and the production of edged tools.

Among the exhibits was a chain of six or eight links and a hook, all said to have been made and welded in an open blacksmith's forge. The hook was of copper and steel, joined about midway of its length, and if joined by an ordinary weld it was certainly an excellent one. Other links were of copper wholly, copper and iron or steel, brass and iron, aluminum,

etc. Necessarily some of these links must have been welded by some process, whether electrical or not. A steel-eyed machinist's hammer with two copper faces welded on was also shown.

Among the exhibits of cast articles were two hatchet heads, one ground on the blade only and the other rough. Both rang when suspended like tempered steel, and the ground one showed a fine cutting edge. A cast razor blade had a hair cutting edge on it.

Rough fragments of castings, broken-off gates, etc., show a radiating structure like chilled metal, very close-grained and without a single blow-hole.

All these results are said to be secured by adding to the molten metal a newly-discovered composition, which is, of course, not yet disclosed, and will probably be covered by patents.

I give these observations and the discoverer's statements for what they are worth, saying only that the exhibits bear every appearance of being genuine.

NOVICE.

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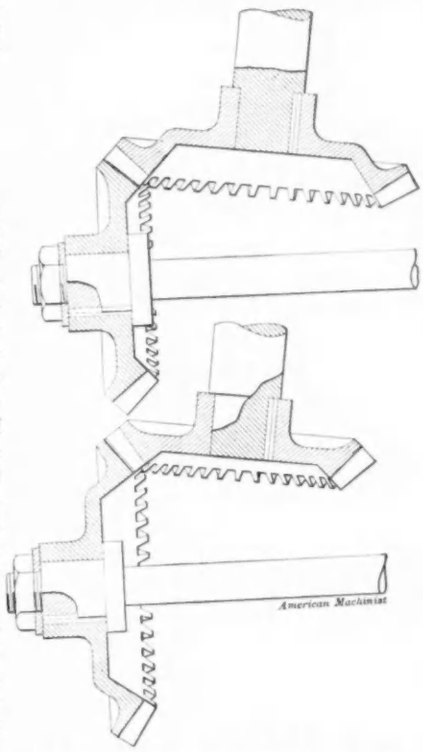
Interchangeable Bevel Gears.

The cut herewith, from a recent patent, embodies an idea in bevel gearing to which it is proper to call attention. The arrangement shown was devised for a chainless bicycle, but is equally applicable to other service, the object being the interchangeability of the gears which are of different diameters and have different numbers of teeth, the changing of the gears also changing the relative speeds of the driving and the driven shafts. The positions of the two shafts are fixed, and when the exchange of gears is made, no change is made in the shafts or elsewhere. The gears are simply made so that the backs of both gears measure the same distance from the common point where the axial lines of the two shafts meet. The details are clearly shown in the cut. The difference in the diameters of the gears shown is not very great, the ratio of speeds when reversed being apparently about 1:1.4, but the difference may evidently be made much greater if desired. Bevel gears have not hitherto been generally considered interchangeable, while the device shown makes a very simple matter of it.



INTERCHANGEABLE BEVEL GEARS.

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Value of Shop Work to the Student.

What possible good can shop work do me? I'm not going to be a machinist or a carpenter! Why must I get down in the sand and make molds from patterns? I don't come here for that! Have I heard these questions once, or a thousand times?

You are not to be pattern makers, blacksmiths or mechanicians, but you are to be designers, testing experts and superintendents, and it is absolutely necessary that your judgment in these things should be developed and that your hands should be trained in the handling of instrument parts. The untrained hand does not know the pressure a fine screw thread will bear; but the knowledge of the cost in time and patience it takes to produce such a thread brings to life a painstaking care in the operator not to injure it. How many of us have endeavored to take a clock apart with a 10-inch screwdriver? How many of us have ruined bicycle parts with heavy wrenches? And how many have tried to cut a copper rod in two with a pair of pocket pliers? These are only the everyday unwitting acts of the average man and boy.

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And who is the man that successfully designs a dynamo? It's not the man who devises for the purposes of electro-magnetic generation a mechanical structure taxing the skill of the founder to the utmost. No, it is the man who constructs for the habitation of the most involved interactions of complex electro-magnetic forces, a metal structure that is a model of simplicity. Hundreds of dollars are often saved by the exercise in matters most theoretical of the hard common sense of the forge and the foundry.

And so I would urge you to do your shop work well; do it so well that in the latter days at a critical moment the training of past years will come back to you; for the hour you will be the carpenter or the blacksmith of your school days and you will surprise yourself as much as your fellows.—Professor Goldsborough in The Purdue Exponent.

Back Volumes of the "American Machinist."

As we have lately received several inquiries for back volumes of our paper which we have been unable to answer satisfactorily, we take pleasure in saying that we have just learned of a set of bound volumes from 1880 to 1887 inclusive, and unbound volumes from 1888 to 1893 inclusive, which are for sale. Inquiries sent to this office will be forwarded to the owner, who is the widow of an old subscriber

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The Bicycle of No Advantage.

"We cannot advise a Westminster subscriber to proceed with his scheme at all. He has got a power of locomotion in his own limbs—if they are sound, and he will but use them—to which all the machinery in the world can add nothing whatever."—"Mechanics' Magazine," April 14, 1832.

"We must abide by the advice we gave a Westminster subscriber in our last number. * * * We *do* hold it to be impossible for an individual to travel faster in the long run in a machine propelled by his own personal strength than he would do by employing his limbs in the usual and natural way. Man is a locomotive machine of nature's own making and not to be improved by the addition of any cranks or wheels of mortal invention."—"Mechanics' Magazine, April 21, 1832.

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Personal.

Will Mr. O. Hermann please send his address to the editor.

Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, recently sailed for Europe in the interests of the company named.

D. R. Clarkson, formerly superintendent of the Niagara Screw Company, Buffalo, N. Y., has recently taken charge of the special automatic machinery and die departments of Mr. J. G. Wilson in Olean, N. Y.

Mr. Tom Roberts, until recently foreman of a machine tool department at the Builders' Iron Foundry, Providence, R. I., has accepted a foremanship with the Wheeler Condenser & Engineering Company, Carteret, N. J.

W. B. Phinney has resigned his position as superintendent of the Walter Chaurant Company, manufacturer of chocolate and indexed confectionery machinery, at the corner of Thirteenth and Hudson streets, to engage in a similar line of business for himself, at 548 West Forty-first street, this city.

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Obituary.

John Keesey, a life-long machinist, died at Wilmington, Del., December 5, seventy-six years old. He was a member of the

firm of Wetherill, Keesey & Wildey, the predecessors of the present well-known firm of Robert Wetherill & Co., Chester, Pa.

Andrew J. Boyce, proprietor of the Boyce Foundry, East Liverpool, Ohio, died December 1, sixty-nine years old.

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Commercial Review.

NEW YORK, SATURDAY EVENING, December 10, 1898.

DYNAMOS AND MOTORS.

Despite the proximity of the holidays it is difficult to see that the demand for electrical machinery for power purposes shows any tendency to abate. Not only are factories still very busy, but they are continually being urged along with new orders which come in to take the place of those which leave the shops. The senior partner in the New York selling firm of a company which makes a specialty of electric power transmission machines says that of late he has been compelled by the press of business to remain at his office until 11 o'clock every evening. He says, moreover, that he is confident that the sales of the company for the last six months have been more than double those of any previous six months in its history.

The General Electric Company's works are busier than ever before, and it is getting better prices for its goods than formerly. Toward the end of the year business usually tends to slacken, but this year seems to be an exception. Many small and medium sized orders for street railway purposes are arriving; for instance, ten motor equipments for the Consolidated Traction Company of New Jersey, one day this week, and ten for the Paterson Railway Company the next day. The company is just beginning the equipment of an electric road in Key West, Fla., ten car equipments having already been ordered, and two of them shipped. November business of the company showed among its features the following: Good sales of power and minning machinery (3-phase alternators); looking up in lighting generators, monocyclic system (single-phase alternators, which can run motors); increase in small motors (up to 4 or 5 horse-power), showing that business is getting down to the lower ranks; good demand for supplies and lamps for winter lighting; decided peak in incandescent lamp sales, showing practically an extension of the field. Several large woolen and cotton mills in New York and the East have ordered equipments of electrical machinery. An official of the company thinks that the bogie of Southern textile manufacture usurpation is being made more hideous than necessary. In competition with the North the South is handicapped by the quality of its labor. The General Electric Company has received an order from J. G. White & Co. to furnish about twenty-five motor-car equipments, with generators, for an electric road which the firm are equipping in Perth, Australia. The company has been asked to build for the underground road that is being constructed at Paris eight electric locomotives and the large quantity of material that goes with them.

The Westinghouse Electric & Manufacturing Company has booked an order from Hanover, Germany, for the motors and controllers of about fifty cars for an electric railway in that city. The Westinghouse Company has of late been fortunate in having considerable work from England. Its sales through its Baltimore representatives are understood to have been good recently and the company in general to be very busy.

INDUSTRIAL EQUIPMENTS.

The Maryland Steel Company has purchased for its marine shops two 100-kilowatt Bullock generators and twelve 5 and 10 horse-power motors of the same make. The Ohio Steel Company has bought some twenty 10 horse-power Crocker-Wheeler motors.

The East Jersey Water Company, Little Falls, N. J., has ordered a Crocker-Wheeler power and lighting plant, consisting of a large generator and several motors. The Nairn Linoleum Company, Kearney, N. J., has contracted for two 150-kilowatt, belted, Eddy generators and about 100 horse-power of C & C motors. Many of the motors will be direct-connected, some with double commutators. They will be of slow speed with a wide range of speed. The Bethlehem Silk Company, Bethlehem, Pa., has ordered a 50-kilowatt Eddy generator to be direct-connected to an Ames engine.

OFFICE BUILDINGS.

Since these structures have been an important factor in the market for dynamos, engines and boilers, a few words in regard to the present status of their construction may be appropriate. The recent fire in the Home Life Insurance Building was not needed to bring about a reaction in the erection of sky scrapers, for such a reaction had come already. The Syndicate Building, some thirty stories tall, now almost ready for occupation, marks probably the maximum of height in this city for a long time to come. Within the past five years have gone up several buildings of over twenty stories, but we do not know of any now contemplated, or in an early stage of construction, which is over sixteen stories. One reason assigned for this is that, congested as is the business population of New York, the supply of office room has outstripped its growth. The large new buildings have drawn away tenants from the old rookeries. The owners of these are compelled in self-defense to replace them by modern buildings, but do not feel that the demand for offices would justify them in erecting structures more than high enough profitably to utilize their ground space. The cost of the foundation required to support an inordinately tall building, and of its safe construction, is also a serious consideration. The problem of securing an elevator service convenient for all floors increases with the hight, and therewith, too, the expense and hazard are augmented. Although some people enjoy getting as far away from the ground as possible, and in at least one sky scraper the rents for the upper floors are higher than for the lower, other persons object to going very far aloft. It may be that this latter disposition on the part of the public has influenced landlords. It is suggested, moreover, that anticipated legislative restrictions have deterred builders from planning edifices they might not be allowed to erect.

With the passing of the most interesting phases of the sky scraper boom, the attention of local electrical selling agencies is being diverted to factories, storage houses, etc., as a market for isolated lighting plants. This industrial demand for lighting material is fair, and while the season's installations ought for the most part to be made by this time, and many of them are, the actual experience of early twilight and the growing need of mills to be equipped for night work keep a tolerable volume of orders constantly coming in. Lighting and power installations are frequently part of the same job, for where a mill owner installs a plant for the transmission of electric energy he is quite likely to improve the illumination at the same time.

Low rates in the Edison circuit are somewhat a deterrent from the installation of isolated plants in the smaller urban buildings. If, as is reported, a $25 000,000 trust is being formed to control the gas and the electric light, heat and power circuits of this city a change may be wrought in that respect.

For one new local office building the specifications for an electric plant have lately been given out. This is a structure which is being erected on Nassau street, partly upon the site of "Nassau Chambers," a medium sized building owned by ex-Governor Morton, which was burned several months ago. The order, which calls for four 50-kilowatt direct-connected machines, may be let as early as next week.

MACHINERY EXPORTS FOR OCTOBER.

The "Monthly Summary of Finance and Commerce," just issued by the Bureau of Statistics, Treasury Department, for the month of October, 1898, shows remarkably heavy shipments of metal-working and electrical machinery.

For that month metal-working machinery exports amounted to $651,256; for October, 1897, $337,702; for ten months ending October, 1898, $4,742,488. The figures for December, 1897, have previously been reported—$539,122. Electrical machinery exports were: October, 1898, $286,818; October, 1897, $116,794; September, 1898, $212,913; ten months end-

ing October, 1898, $1,939,474. Locomotive engines: October, 1898, 43 in number, valued at $326,156; October, 1897, 48, at $427,649; September, 1898, 46, at $492,776; ten months ending October, 1898, 517, at $4,663,849; ten months ending October, 1897, 307, at $2,747,077. Stationary engines: October, 1898, 44 in number, aggregating, $30,552; October, 1897, 35, at $24,985; September, 1898, 36, at $20,380; ten months ending October, 1898, 438, at $309,206; ten months ending October, 1897, 476, at $311,607. Boilers and parts of engines: October, 1898, $105,285; October, 1897, $73,964; September, 1898, $153,228; ten months ending, October, 1898, $1,007,576; ten months ending October, 1897, $527,916. Printing presses and parts thereof: October, 1898, $66,234; October, 1897, $105,460; September, 1898, $67,502; ten months ending October, 1898, $662,491; ten months ending October, 1897, $575,874. Pumps and pumping machinery: October, 1898, $193,886; October, 1897, $135,804; September, 1898, $187,252; ten months ending October, 1898, $1,809,167. Shoe machinery: October, 1898, $66,125; October, 1897, $103,283; September, 1898, $101,265; ten months ending October, 1898, $784,415.

GOVERNMENT CONTRACTS.

The contract for a 40-ton jib crane for the Port Royal Naval Station has been awarded to the American Hoist & Derrick Company, St. Paul, at $39,950.

A battery of five boilers will be installed at the Boston Navy Yard by Burhorn & Granger, 136 Liberty street, New York, at $11,887.57. Proposals are invited by the Bureau of Yards and Docks to install at the Boston Navy Yard an electric light and power plant. Bids will be opened December 23.

The machinery and tools at the Watervliet arsenal are being inspected with a view to replacing what is worn out or unserviceable.

Machinery and tools are wanted for the Portsmouth (N. H.) Navy Yard, bids to be opened December 20. The items are as follows: Upright molding machine; forge for heating stock for bolt header; portable pneumatic riveter; 2-inch, single head, bolt cutter; automatic plug machine; block turning lathe; 37-inch boring and turning mill; duplex air compressor; horizontal type automatic, stop motion heading, upsetting and forging machine; standard chain saw mortiser; mortiser attachment suitable to be applied to a post, to operate horizontally; 36-inch diameter by 10-inch face universal automatic gear cutting machine; two universal portable radial drills; two radial countersinking machines; three manufacturers' drills; two vertical sensitive drills; revolving turret screw machine; heavy upright boring machine; steam engine direct-current dynamo.

Bids were opened, December 6, upon machine tools for the New York, Washington and Portsmouth (N. H.) navy yards. For the New York Navy Yard supplies the lowest bidders made tenders as follows:

Horizontal boring and drilling machine, Manning, Maxwell & Moore, $2,500; 15-inch pillar shaper and 22-inch pillar shaper, J. W. Cregar, Philadelphia, $325, $252 and $425 on the first machine and $480 on the second; screw cutting engine lathe, Cumberland Dugan & Co., Baltimore, $399; screw machine with wire feed, Hill, Clarke & Co., $699; wet tool grinder, Cumberland Dugan & Co., $150; 72-inch universal radial drilling machine, Niles Tool Works Company, $1,029; 24-inch swing wood turning lathe, J. W. Cregar, $85; S. A. Woods Machine Company, the same; twist drill grinder, Manning, Maxwell & Moore, $63; hydraulic copper pipe bender, no bids; hydraulic jacks, Francis H. Stillman, $833.80 and $1,159.40; vertical milling machine, U. Baird Machinery Company, $915.75; combined cutting-off lathe and nut and bolt head facing machine, Manning, Maxwell & Moore, $190 and $215; vertical wood-boring machine, same bidders, $110; machine for threading and cutting off steam and gas pipe, J. W. Cregar, $108; pipe threading and cutting machine, same bidder, $485.

For the Washington Navy Yard the lowest bids were these: Combination hand and power feed surfacing machine, U. Baird Machinery Company, $307.50; pedestal tenoning machine, J. W. Cregar, $180; two wood turning lathes, same bidder, $170; universal horizontal drilling and boring machine, Detrick & Harvey Machine Company, $1,800; screw cutting engine lathe, W. E. Drew, $479; 18-inch screw cutting engine lathe, same bidder, $367.

The following were for the Portsmouth Navy Yard: Bolt cutter, Philadelphia Machinery & Supply Company, $297; shaping machine, same bidder, $285; universal brass lathe, same bidder, $503; pipe machine, J. W. Cregar, $210; engine lathe, Cumberland Dugan & Co., $1,038; universal radial drill, Niles Tool Works Company, $825; two 21-inch manufacturers' wheel and lever drills, Cumberland Dugan & Co., $90.75; combination chucks, etc., J. W. Cregar, $142.78; self-acting planing machine, Cumberland Dugan & Co., $660; No. 6 universal trimmer, U. Baird Machinery Company, $41; universal trimmer, Manning, Maxwell & Moore, $118; combined drip and cross-cut saw, Cumberland Dugan & Co., $85.

MISCELLANEOUS.

North Carolina has risen, since 1890, from a position ninth on the list of Southern cotton spinning States to that of second. Only South Carolina in the South is ahead of it, while in the North Massachusetts, New Hampshire, Rhode Island and Connecticut have a greater number of spindles. In North Carolina there are now 220 cotton mills.

The committee on water of the Council of Allegheny City, Pa., has recommended the acceptance of the bid of William F. Patterson, of Erie, Pa., to furnish for the Howard street pumping station a 250 horse-power boiler and Playford stoker; price, $5,298.

A local Mexican exporter last Saturday was asking quotations on machine tools to the value of nearly $6,000 and more than $8,000 worth of railway material.

Consul-General W. R. Halloway writes from St. Petersburg to the Department of State as follows:

"Mr. Thomas C. Purdy, representative of the New York Air Brake Company, has obtained through Consul Smith of Moscow a trial order from the Russian Government to equip twelve freight locomotives and 200 freight cars with their air brake, for which the price paid will be $25,000. This contract was obtained in competition with French, German and Russian companies. The Westinghouse air brake has been in use on passenger trains in Russia for about two years, and the Westinghouse Company has purchased a building in this city and is now putting up a plant to fill a trial order similar to that given to the New York Air Brake Company. Should the order given the latter company prove satisfactory, it will also build works in St. Petersburg. There are said to be mechanical difficulties to be overcome in adapting the air brake to the freight locomotives and cars in use on Russian railroads, but should they be overcome the entire freight equipment, consisting of 10,000 locomotives and 500,000 cars, will be equipped with air brakes as rapidly as possible, the cost of which, it is estimated, will reach $50,000,000. A Russian company has been organized to run a line of twenty-one coast steamers from Vladivostock to Port Arthur and leading ports in the Pacific Ocean. Contracts have been awarded for twelve of these steamers."

The Chilian Congress offers a bounty of $125,000 for the establishment in that country of an iron foundry on a sufficiently large scale. Plentiful iron ore and other natural advantages exist in Chili.

We learn from the Chicago Pneumatic Tool Company that its British and Continental trade is continually on the increase and that the call for its tools in this country is larger than ever before, taxing to the utmost its increased manufacturing facilities. The activity in ship and navy yards has increased the demand and the railroads are buying better than at any previous time.

Mr. Joseph Leiter has bought from the International Air Power Company the foreign rights in the Hoadley-Knight compressed air power patents. His intention is to try to introduce them upon the conveyances of London, Paris, Berlin and other cities of Europe.

CHICAGO MACHINERY MARKET.

Never has the inquiry for electrical power among manufacturers and business houses in Chicago been so general as now. Especially is this true among owners, who contemplate moving in the spring. Quite a number of people in the business centre are finding out that they must make changes in order to accommodate a larger trade. They are figuring with the electrical machinery makers for various installations. Several printing houses lately adopted electrical outfits and a half dozen competitors are now investigating the same field. Armour & Co. are putting in a large central plant in the stock yards. The other three large packers are now thinking of making the same improvement. Reid, Murdoch & Co., wholesale grocers, this week purchased an outfit consisting of a motor of about 300 horsepower and corresponding equipment. In many lines there is active the same inquiry.

Yet holiday influences are felt by manufacturers, who deal chiefly with power consumers of electrical machinery. And among some of the makers complaint is heard that prices are not what they should be. One feature of recent notice is that in a number of the smaller cities new manufacturers of electrical power material are to be found. Like small machine shops, their fame rarely spreads beyond the limits of their county, to which they confine their operations, consisting largely of repair work and the occasional manufacture of dynamos and generators for home consumption.

For mining machinery the outlook is bright. A number of large deals are under way for the development of mining properties in the West and in Mexico, and early in the new year, it is believed, several large contracts for these operations will be closed. Current trade is fairly active. Among recent orders placed at Chicago was one with the Gates Iron Works for nine sets of Cornish rolls, largest size, to go to Australia.

Railroad companies in the West are surpassing all records in the purchase of steel rails, cars, etc., for next year's deliveries. The machinery men are looking for a generous buying movement from the same source. It has not yet attained phenomenal proportions, but has lately been quite fair. The steel markets are hardening and buyers are more numerous.

The Q & C Company continues very busy. Demand for its new power sawing machine No. 11, is large, also for its new duplex centering machine, besides snow flangers and other specialties. Foreign sales are increasing.

▲ ▲ ▲

Quotations.

NEW YORK, Monday, Dec. 12.

Iron—American pig, tidewater delivery:

No. 1 foundry, Northern	$11 25 @ 11 50
No. 2 foundry, Northern	10 75 @ 11 00
No. 2 plain, Northern	10 50 @ 10 75

(*Quotations Continued on page 41.*)

Business Specials.

Gear wheels, gear cutting, Grant; see page 18.

Forming Lathes. Mer. Mach. Tool Co. Meriden, Conn.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

For Sale or Rent—Foundry and machine shop with additional land, in good condition and well equipped for medium heavy work; capacity of foundry 7 tons per day; located on railroad within eight miles of New York; terms easy. Call or address J. F. Sweasy, 26 Nassau street, New York.

Complete set American Machinists, 1877 to 1898, for sale; first 18 vols. bound in morocco, uniform in style (binding alone cost $4.75 per vol.); 1898 vol. 19 in cloth; 1897 vol. 20 includes advertising, and is in leather; 19 volumes have name of private individual on side; will sell the twenty volumes complete for $100. Address Volumes, care AMERICAN MACHINIST.

Wants.

Situations and Help Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded; but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents.

Situations Wanted.

Dr'ft'n; careful, steady dr'ft'n; good, gen'l knowl'ge; pes. pos. with good concern; best refs Box 159, AM. MA.

Situation wanted by tool, die and model maker on small work. Tool job or charge of shop on light work. References. Box 150, AM. MACH.

Wanted—Position as manager or superintendent; 15 years' exp. on machine tools, automatic and fine mach'y; member A. S. M. E.; at present sup't of large eng. works; would prefer to work on per cent. basis vicinity of New York or Philadelphia. Box 158, AM. MA.

Situation wanted by first-class all round machinist; 20 years' experience in marine work, dynamos, switches and tool building. Box 165. AM MACHINIST.

Wanted—Situation as mach. salesman by young man of practical mechical ability who has had experience as salesman. Address Box 1774, New York city

Wanted—Position as foreman in engine and jobbing shop, or will take shop by ton at low figure; 22 years' experience; first-class work guaranteed. Box, 164, AMERICAN MACHINIST.

Salesman—Intelligent young man wishes to go under instructions to become a salesman with a large machine and tool firm; unusual ability in mechanical lines; no salary expected. Box 162; AM. MACHINIST.

Experienced advertising and corresponding clerk accustomed to cataloging and writing up mach'y, desires pos in that capacity; practically acquainted with mech'l and elect'l matters; refs. given Bx. 161, AM. MA.

Experienced foundry foreman desires a change; competent to handle any number of men on heavy or light work, engine, machine tool or electric preferred; at present in charge of shop running fifty men. Address Box 160, AMERICAN MACHINIST.

Help Wanted.

Wanted—Electric'n exp'd in erecting travel'g cranes. Address Pawling & Harnischfeger, Milwaukee, Wis.

Wanted—Inspector for fine, interchangeable work; state refs. and salary expected. Box 153, AM. MACH.

Wanted—Foreman for machine shop working about 75 men. State experience, references and wages desired Address, Box 147, AM. MACH.

A draftsman experienced in designing steam engines gas engines and pump work of medium and large sizes, with a practical knowledge of the construction in the above lines Address, giving age, reference and terms, West Penn, care of AMER. MACHINIST.

Wanted—A man of experience for Boston Shop, to do estimating on job gear cutting work. Address Gear, care of AMERICAN MACHINIST.

Wanted—First-class machinist familiar with pump work, to take charge of small pump shop as a working foreman. Box 114, AMERICAN MACHINIST.

Wanted—A1 Draftsman with experience on printing presses. Address W. H. Golding, 183 High St., Boston, Mass., stating age, exper. and pay required.

Wanted—Two good machinists for lathe and assembling. Address, stating age, last employer, class of work and wages exp'd, Box 549, Wheeling, W. Va.

Wanted—A thoroughly experienced designer and draftsman who has had extensive practice on large Corliss engines and marine engines. Address, with references and full particulars, Box 452, Pittsburg Pa.

Wanted—Superintendent; age about 40; modern practice; for building machine tools; require first-class, active man; all communications confidential; give full particulars stating exp. Box 154, AM. MACH.

Patternmaker—A good mechanic wanted for making engine and other similar patterns; give age, exp. and wages expected; the job will be steady for suitable man. Apply or address Kenney & Co., Scottdale, Pa.

Machinery salesman with established trade in presses, rolling mills and wire drawing machinery; position open January 1; first-class, experienced men only need apply; all communications will be treated strictly confidential. Box 155, AMERICAN MACHINIST.

Wanted—Patternmaker with knowledge of drawing; must be practical and competent to take charge of patternmaking and improvement department in agricultural implement factory in large town; good situation for the right man. Ad. Box 156, AM. MACH.

Wanted—A first-class superintendent for a machine tool works; one who is entirely familiar with the business, from the drawings to the finished machine; must be a hustler, and come well recommended; state age and where last employed; one familiar with the building of planers preferred; a good position for a first-class man. Address Box 14 , AMER. MACHINIST.

Wanted—Boiler shop manager and supt.; one who is thoroughly competent to take charge of a shop employing from 30 to 60 men; is expected to handle sales, estimates, etc; in applying state exp., refs and salary expected, also how soon could begin work if engaged. Address Box 125, AMERICAN MACHINIST.

Wanted—A large manufacturing plant in the iron line (working about 500 men) about to locate in Chicago, wishes to engage a supt. and foreman for each d'p'tm't, viz, forge shop, mach. shop, wood shop, paint shop and eng'ring d'p'tm't; replies cannot be too specific in all points. Ad. Lock Box 1194, Chicago, Ill.

Miscellaneous Wants.

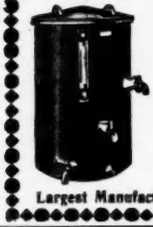
Advertisements will be inserted under this head at 30 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper catalog free. E. G. Smith, Columbia, Pa.

Rock. Dies & Die Making, $1. J. L. Lucas, Prov., R. I.

The CROSS OIL FILTER

actually reduces oil bills 50% or more. Sent on approval. Capacities 3 to 120 gals. per day. Used in 18 countries. Testimonials from the leading firms in every field of industry.



THE BURT MFG. CO.
AKRON, OHIO, U. S. A.
Business Established 8 Years.
Largest Manufacturers of Oil Filters in the World.

THE MECHANICAL ENGINEER'S POCKET-BOOK. Fourth Edition, Revised. Now Ready

A Reference Book of Rules, Tables, Data and Formulæ for the Use of Engineers, Mechanics and Students By William Kent, A.M., M.E., Consulting Engineer, Member Amer. Soc'y Mechl. Engrs. and Amer. Inst. Mining Engrs. 12mo. Morocco. Upward of 1,100 pages. $5 00. Order through your bookseller, or copies will be forwarded postpaid by the publishers on the receipt of the retail price. JOHN WILEY & SONS, 53 East 10th Street, New York City.

Jenkins Standard '96 Packing

weighs 33⅓ per cent. less than most joint packings, does not Rot, Burn or Blow out, and will last longer, therefore the cheapest and best for all purposes. Good buyers compare weights. Genuine stamped like cut.

JENKINS BROS., New York, Boston, Philadelphia, Chicago.

Miscellaneous Wants—Cont'd.

Wanted—An 8 ft. boring mill quick. Box 163, AMERICAN MACHINIST.

The Dutton Wet Twist Drill-Grinder is sold by the Garvin Machine Co., New York City.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Li't and h'vy mchy. exp'l and sp'ly b'l't. mdrn. appl. and tls.; prices reas'ble. Wm. H. Baker, Trenton, N. J.

Plant wanted for producing bright round stock up to 2 1-4 in. in diameter. Full particulars and tender to Garrard, Ryland Street. Birmingham, England.

Wanted—A number of second-hand screw cutting lathes, stroke planers, small size screw machine and one milling mch. H. Bertrand, Box 27, Glen Ridge, N. J

Engineers and firemen, send 10 cents for a 24-page pamphlet contaiuing a list of questions asked by an examining board of engineers. George A. Zeller, bookseller, 18 S. Fourth Street, St. Louis, Mo.

Wanted a customer for a 4-spindle milling machine, which has a table 20 in. wide, 8 ft. long; it has been in use for about three years and was made by Beaman & Smith. Address Box 157, AMERICAN MACHINIST.

Wanted—Lathe 30 in swing to take 9 feet between centers. Must be A 1 modern mach. Lodge & Shipley preferred. State lowest cash price on board the cars at Chicago Must be cheap. James Rowe, 76 Jackson Boulevard, Chicago.

Wanted—Machine tool man with from $10,000 to $20,000 to take contract to build twenty-four well-known lathes per month for five years; drawings, patterns, gigs, templates and special tools are furnished; straight sailing. Address Box 141, AMER. MACHINIST.

Wanted—Copies of November 10, 1898, issue. We will extend any subscription in the United States 1 month for a copy in good condition. Send paper with name and address to subscription Department of AM. MACH.

Institutions retiring from business having machine tools, brass or wood working machinery, will find it to their interest to correspond with us. We purchase complete plants or handle them on com. C. C. Wormer Mach Co., 55-59 Woodbridge st., W., Detroit, Mich.

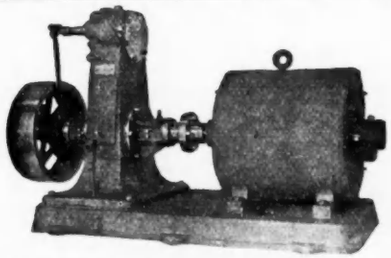
A Belgian eng. who had the management of large establishments and possesses influential connections wishes to represent in Europe mfg works producing cast iron, steel in blooms, in profile, cons't companies, &c. Address Mr. Lejeune, engineer, Charleroi, Belgium.

Cleveland Gear Works,

86 Seneca Street,
CLEVELAND, OHIO.

Gear Wheels and Gear Cutting
Of all descriptions.

GET OUR PRICES.



Compact Generating Sets,
Sizes 2½ to 15 K. W.

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Closed or Open Type
Ironclad Dynamos and Motors.

▲ ▲ ▲

Slow Speed Generators and Motors
for direct or belt driving.

▲ ▲ ▲

Electric Power Transmission and Lighting Systems.

The C & C Electric Co.,

Main Offices: 143 Liberty Street, New York.

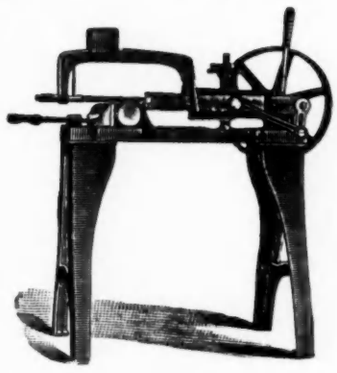
SALES OFFICES:
BOSTON, MASS., 19 High Street.
CHICAGO, ILL., 1012 Monadnock Block.
PHILADELPHIA, PA., 633 Arch Street.
LONDON ENGLAND, 47 Victoria Street, S. W., Westminster.

"The best is as good as any."

The New

Automatic and Gravity **Feed**

Q & C Shop Saw



Cuts { Tool Steel, Machinery Steel, Iron, Brass and All Other Metals.

Price—'Way Down.

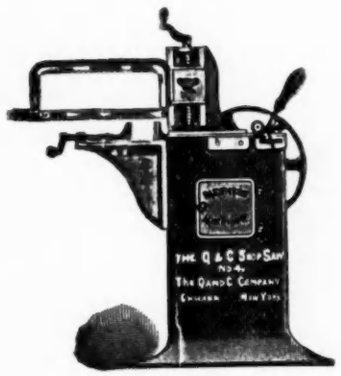
Quality—'Way up.

Shop Saws,

Portable Rail Saws,

Cold Power Saws,

For All Purposes.



Send for Catalogue.

Q & C Company,

Chicago. New York.

LONDON: Chas. Churchill & Co.
PARIS: Hounsfield & Fils.
BERLIN: Schuchardt & Schutte.
MADRID: J. G. Neville & Co.

(Quotations continued from page 40.)

Gray forge, Northern	$10 00 @ 10 25
No. 1 foundry, Southern	11 50 @ 11 75
No. 2 foundry, Southern	11 25 @ 11 50
No. 3 foundry, Southern	10 75 @ 11 00
No. 1 soft, Southern	10 75 @ 11 00
No. 2 soft, Southern	11 25 @ 11 50
Foundry, forge, Southern	10 25 @ 10 50

N. B.—To these prices for Northern irons 50c. per ton may have to be added, some Northern furnaces having advanced prices that amount. In the quotations on Southern irons an advance of 25c. per ton has been incorporated above.

Bar Iron—Base—Mill price, in carloads, on dock: Common, 1.05 @ 1.10c.; refined, 1.15 @ 1.20c. Store prices: Common 1.30 @ 1.35c.; refined, 1.35 @ 1.50c.

Tool Steel—Base Sizes—Standard quality, 6 @ 7c., with lower prices on some brands; extra grades, 11 @ 12c.; special grades, 16c. and upward.

Machinery Steel—Ordinary brands, from store, in small lots, 1.45 @ 1.55c.

Cold Rolled Steel Shafting—Base sizes, from store, 2.25c. and upward, according to brand and quantity. A ruling figure for moderate amounts is 2.31c.

Copper—Carload lots, Lake Superior ingot, 12¾ @ 12⅞c.; electrolytic, 12⅝ @ 12¾c.; casting copper, 12½ @ 12⅝c.

Pig Lead—Carload lots, 3.62½ @ 3.65c., f. o. b. New York.

Pig Tin—For 5 and 10 ton lots, 18.12½ @ 18.20c., f. o. b.

Spelter—In carload lots, 5.25 @ 5.35c., New York delivery.

Antimony—In cask lots, 8.70 @ 9.50c., according to brand, Cookson's being quoted at 9⅛ @ 9½c.

Lard Oil—Prime city, present make, the leading brand quoted at 45 @ 46c., in wholesale lots.

▲ ▲ ▲

Manufacturers.

Mitts & Merrell, Saginaw, Mich., are doubling the size of their plant.

The Hercules Pipe Company, of Anniston, Ala., will enlarge its plant.

Mark Penny is contemplating the erection of a machine shop at Riverside, Cal.

The Dennis Novelty Company has decided to move its factory from Findlay to North Baltimore, Ohio.

J. H. Minge & Son, Founsdale, Ala., contemplate the installation of new rope and wrapping twine machinery.

Geo. B. Evans is to erect at Tenth and Spring streets, Philadelphia, Pa., a manufacturing building four stories high, 20x100 feet.

The A. S. Reed & Brother Company were recently granted a permit to erect an addition to the mill of the Jackson & Sharp Company, Wilmington.

A new addition is being built at the Utica Steam Cotton Mills, on the north side of the engine room and adjoining the picking department.

The Elmira Manufacturing Company, of Elmira, N. Y., was recently organized with a capital of $300,000 to manufacture hydraulic and steam machinery.

The Gaston Manufacturing Company, of Cherryville, N. C., has built an addition to its mill, which will be equipped with spinning and carding machinery.

The Union Iron Works, San Francisco, Cal., is building a foundry with the view of making steel by the Tropenas process, which was referred to in our issue of July 14 last.

The firm of W. G. Nagel & Co. has been organized for the purpose of conducting a general business in electrical machinery, supplies and construction, in Toledo, Ohio.

McLoughlin & McNamara are about to build a one story and basement brick boiler house, 24x35 feet, for J. J. Felin, in the rear of 4148 Germantown avenue, Philadelphia, Pa.

The Sumter Cotton Mills, of Sumter, S. C., will be improved. A lot of new machinery will be put in each department, including a new and larger engine to supply the additional power that will be needed.

The Michigan Alkali Company, of Wyandotte, Mich., will immediately begin the construction of large addition to plant No. 1 for manufacturing Portland cement. The new plant will have a capacity of 450 barrels a day. This, together

with another addition to increase facilities for manufacturing soda ash, at works No. 2, will bring the number of the employees of the company up to 1,000. The present force is 750 men.

The C. W. Hunt Company, of Staten Island, N. Y., is erecting an addition to its plant. This addition will be one story and have a floor area of 13,000 square feet.

The ginning establishment of R. H. Johnson & Co., Brownsville, Tenn., was recently destroyed by fire. The damage to machinery and fixtures amounted to about $10,000. The building will be reconstructed.

The Daisy Manufacturing Company, capital $50,000, has been chartered at Burlington, N. C., by S. M. Holt, W. C. Curtis and J. P. Faucette, to enlarge and operate a cotton mill established at that place about a year ago.

The Illinois Steel Company has begun the building of a two story power house for its electrical plant. The building is to cost $13,500. It is to be located near Strand and Eighty-seventh streets, covering 115x149 feet of ground.

The People's Gas Light & Coke Company will build a new factory at the southeast corner of Superior and Townsend streets, Chicago, Ill. It will be one story high, of brick and stone, covering an area of 130x240 feet, and will cost $15,000.

The Birmingham Machine & Foundry Company has let to the Southern Bridge Company a contract to build a new foundry, 100x200 feet, at their plant at East Birmingham. The new foundry will not take the place of the old one, but will be used as an addition.

The Petit Ornamental Iron Company, of this city, is erecting a shop and factory building at Ambler, Pa., and is having plans and specifications prepared for another foundry building, with full power complement. Details of the same will be given later.

The large mill of R. R. Claiborne, in the south part of Iola, Kan., was burned recently. The fire started from escaping gas, a plumber having left a plug out while working. The fire under the boilers ignited the gas. The loss is upward of $6,000, with no insurance. It will be rebuilt.

The Electric Storage Battery Company has just made arrangements to double the capacity of its plant. Buildings suitable for the purpose are to be erected adjoining the present ones at Nineteenth street and Allegheny avenues, Philadelphia, Pa., which, it is understood, will be leased by the company.

An entire new plant is contemplated by the Schoen Pressed Steel Company, whose steel car building works are now located in Allegheny, Pa. The new plant will turn out about forty steel cars a day. It will be located in the Monongahela Valley, and will cost in the neighborhood of $2,000,000. Work on the new plant will begin at once.

A big manufacturing building will be erected at Cleveland, Ohio. It is for the Forest City Foundry & Manufacturing Company, Wm. Strangward, president. Fugman & Uhlrich are the architects. The building will be five stories high, of steel and brick, and of especially substantial construction. The building will have a frontage of 133 feet and a depth of 90 feet.

The Mesta Machine Company is the name of the new company formed by the consolidation of the Robinson-Rea Manufacturing Company, of Pittsburg, and the Leechburg Foundry & Machine Company, of Leechburg, Pa. George Mesta is president of the new concern and W. H. Rea is treasurer. The new company has bought the plants and business of the other two companies and has also bought a tract of land near Homestead from George Mesta, upon which the new company will immediately erect a large plant for making steel, sand and chilled rolls, machinery for rolling mills, steel plants and tin plate mills and machine-molded steel gear and ingot molds.

The Hendey Machine Co.,

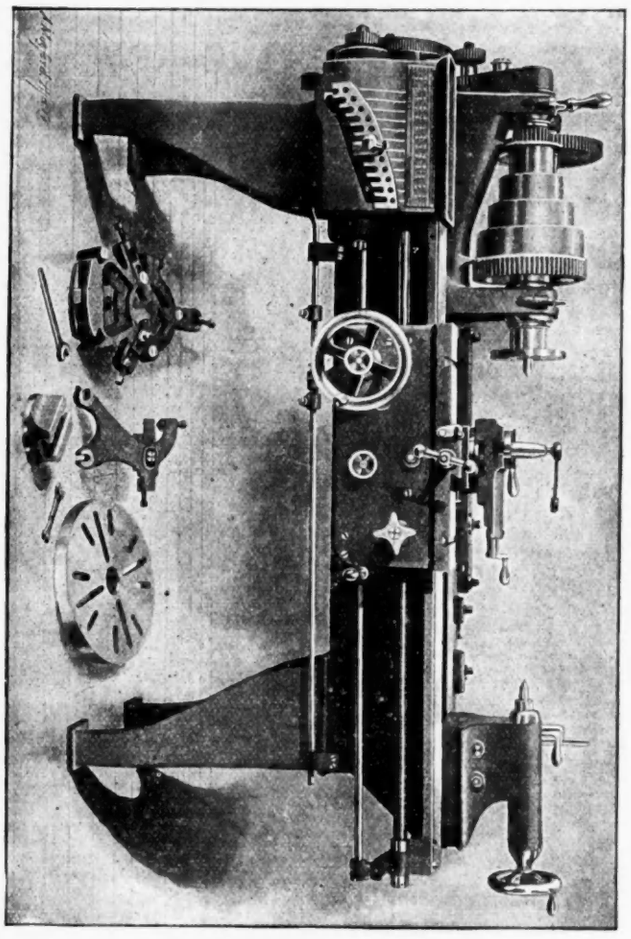
Torrington, Conn.

AGENTS FOR THE PACIFIC COAST:
Pacific Tool & Supply Co., San Francisco, Cal.

J. W. Cregar, Philadelphia Bourse Exhibition.

EUROPEAN AGENTS:
Schuchardt & Schutte, Berlin, Vienna, Brussels.
Chas. Churchill & Co., Ltd., London and Birmingham, Eng.
Adolphe Janssens, Paris, France.

16 in. x 6 ft. Hendey-Norton Lathe.



THE HENDEY-NORTON ENGINE LATHE is the most modern type of engine lathe extant. Why? Because it has the best improved attachments known for the rapid and accurate production of high-class lathe work in use on engine lathes at the present time.

One is the Norton arrangement of change gears for screw cutting. All the change gears are mounted in the gear box ready for use. The different pitches are obtained by the simple movement of handle in gear box from one notch to the other, carrying with it an intermediate gear meshing into the cone of change gears. Thus every thread required in ordinary use is obtained on the instant, and this applies equally well to the feeds.

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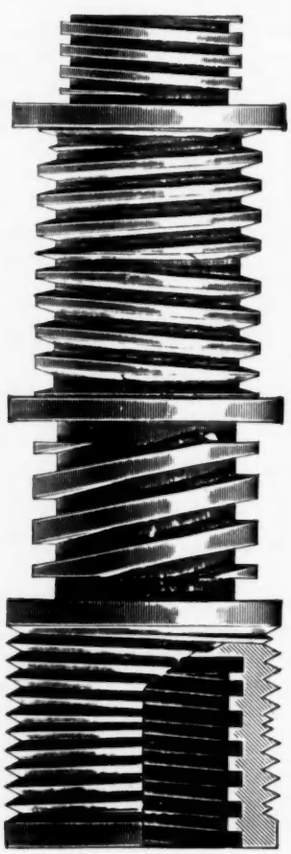

In this specimen of thread cutting we have a good illustration of the application of the above features; but it is here shown to illustrate in particular what our Automatic Stop will do. It shows how threads can be cut to and from shoulders, both internally and externally, tool stopping to a certainty, and with work in motion. This feature is equally applicable in turning work in duplicate. The Automatic Stop is at once positive and simple.

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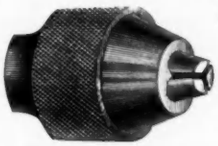

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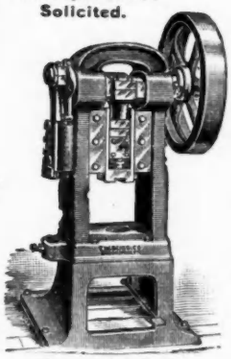

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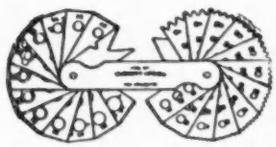

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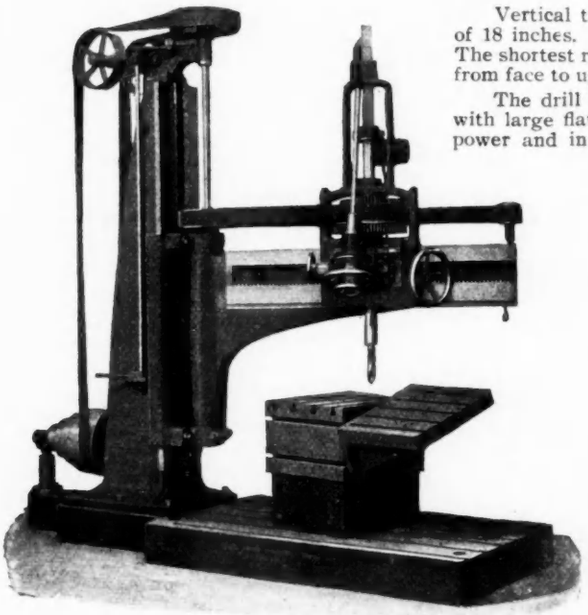

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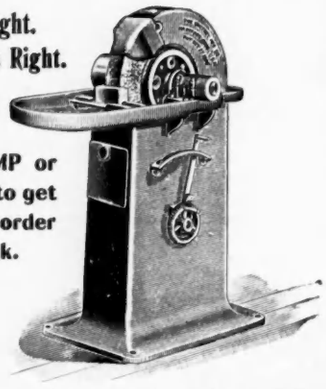

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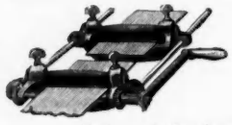

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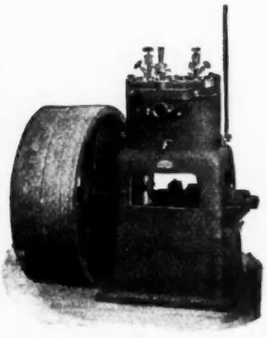

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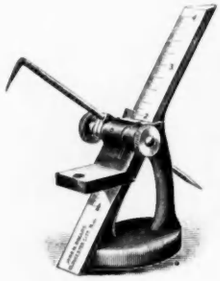

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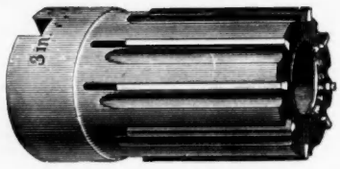

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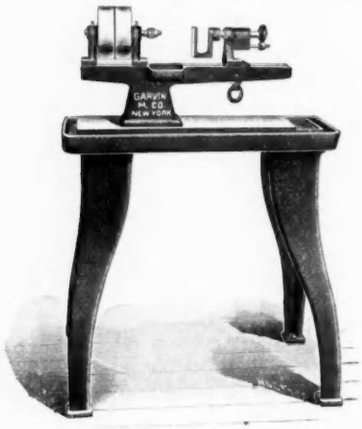

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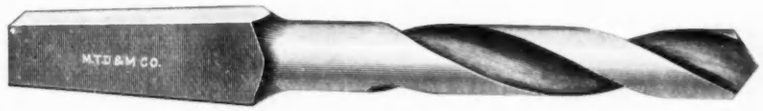

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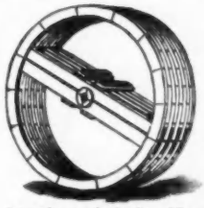

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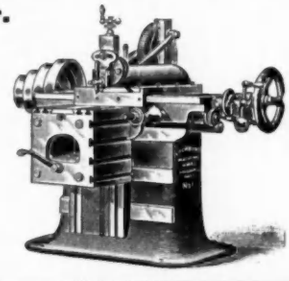

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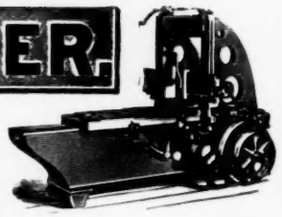

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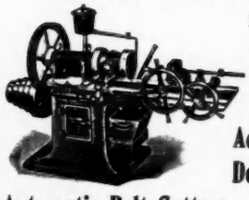

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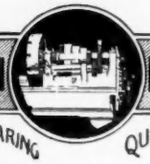

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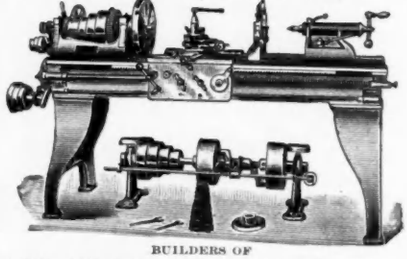

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